RESPIRONICS

PLV-100 Service Manual

RESPIRONICS

CHAPTER 1: INTRODUCTION

1.0 SERVICING AND WARRANTY 1-1
1.1 SERVICE LOCATION 1-1
1.2 SERVICE AND INSPECTION FORMS 1-2
1.3 RECOMMENDED SERVICE REPAIR, AND TEST EQUIPMENT 1-3
1.4 ENGINEERING CHANGE ORDERS 1-5
1.5 EQUIPMENT INSPECTION 1-5
1.6 AUTHORIZED SERVICE CENTERS 1-5
1.7 SERVICING GUIDELINES 1-5
1.8 SERVICING GUIDELINES 1-7

CHAPTER 2: WARNINGS, CAUTIONS AND NOTES

2.0 WARNINGS 2-2
2.1 CAUTIONS 2-2
2.2 ESDS CAUTIONS 2-3

CHAPTER 3: SPECIFICATIONS AND ALARMS

3.0 FRONT PANEL CONTROLS 3-1
3.1 FRONT PANEL VISUAL INDICATORS 3-1
3.2 TEMPERATURE SPECIFICATIONS 3-1
3.3 PHYSICAL 3-2
3.4 OPERATION TIME ON BATTERIES 3-2
3.5 BATTERY CHARGING 3-2
3.6 ALARM OR ALERT INDICATORS 3-2
3.7 POWER SOURCES 3-3
3.8 CONNECTIONS FOR 220 OR 240 VAC OPERATION 3-3

CHAPTER 4: TROUBLESHOOTING

CHAPTER 5: OPERATIONAL CHECKS

5.0 DIAGNOSTIC CHECK 5-1
5.1 UNIT START-UP AND AC/DC OPERATION 5-1
5.2 POWER BOARD VOLTAGES 5-2
5.3 CHASSIS TO GROUND TEST 5-3
5.4 LOW VOLTAGE ALARM TEST 5-3
5.5 ALARM CAPACITOR TEST (POWER BOARD F35950) 5-4
5.6 TIDAL VOLUME DISPLAY RANGE 5-4

5.7 RATE: PATIENT BPM DISPLAY RANGE 5-4
5.8 INSPIRATORY FLOW RATE DISPLAY RANGE 5-4
5.9 I:E RATIO DISPLAY RANGE 5-4
5.10 PISTON/CYLINDER OPERATION 5-4
5.11 MEASURE VOLUME DELIVERY 5-4
5.12 OUTER LIMIT SWITCH OPERATION 5-5
5.13 ZERO REFERENCE SOLENOID, PRESSURE GAUGE CHECK 5-5
5.14 CYLINDER LEAKAGE CHECK 5-6
5.15 DUMP VALVE 5-7
5.16 PRESSURE RELIEF VALVE OPERATION 5-8
5.17 ASSIST CONTROL MODE OPERATION 5-8
5.18 SIMV MODE OPERATION 5-9
5.19 INSPECT POWER SWITCH 5-9
5.20 VISUAL INSPECTION 5-10
5.21 INSPECT FOR ECOS 5-10
5.22 LEAKAGE CURRENT CHECK 5-10
5.23 GROUND RESISTANCE TEST 5-10

CHAPTER 6: PREVENTIVE SERVICE
6.0 PREVENTIVE SERVICE PROCEDURES 6-1
6.1 MOTOR CHANGE REQUIREMENTS 6-2
6.2 PLV POWER SWITCH REPLACEMENT PROCEDURE 6-3
6.3 ECOS 6-11

CHAPTER 7: DISASSEMBLY, INSPECTION, AND REASSEMBLY
7.0 REMOVE THE TOP, BOTTOM, AND SIDE PANELS 7-1
7.1 LOWER THE LEFT MODULE 7-1
7.2 REPLACING THE TOROID ASSEMBLY 7-1
7.3 LOWER THE RIGHT MODULE 7-2
7.4 LOWER THE FACEPLATE MODULE 7-4
7.5 REMOVAL OF THE DIGITAL BOARD 7-5
7.6 REMOVAL OF THE VENT ASSEMBLY 7-6
7.7 CALIBRATE AIRWAY PRESSURE LIMIT 7-7
7.8 ELECTRONIC DUMP SERVICE (POWER BOARD F35950) 7-9
7.9 CALIBRATE AIRWAY PRESSURE LIMIT (ELECTRONIC DUMP AND POWER BOARD F35930) 7-10
7.10 REMOVE PATIENT OUTLET ASSEMBLY (VERSION 1) 7-10

7.11 REMOVE PATIENT OUTLET ASSEMBLY (VERSION 2) 7-11
7.12 REMOVE BACK MODULE 7-12
7.13 REASSEMBLE BACK PANEL 7-13
7.14 REMOVAL OF THE MOTOR ASSEMBLY 7-14
7.15 RELOCATING THE CHECK LEAF VALVE 7-15
7.16 MOTOR LEAD RESISTANCE TEST (OPTIONAL) 7-16
7.17 MOUNTING PLV-100 OPTICAL SWITCH ASSEMBLY 7-17
7.18 SILENT BLOCK/BALL SCREW ASSEMBLY 7-19
7.19 BALL SCREW ASSEMBLY INSPECTION 7-20
7.20 BULKHEAD, CYLINDER, AND PISTON SERVICE 7-21
7.21 BALL SCREW LUBRICATION 7-23
7.22 35903 POWER BOARD RETROFIT 7-25
7.23 UNIT FINAL ASSEMBLY 7-28

CHAPTER 8: MANDATORY ENGINEERING CHANGE ORDERS
8.0 ECO #: 1156 ENCODER CHANGE 8-1
8.1 ECO #: 2073 HOUR METER INSTALLATION 8-3
8.2 ECO #: 2730 WATCHDOG TIMER RESISTOR CHANGE 8-4
8.3 ECO #: 2876 MULTIPLEXER U19 CHANGE (NATIONAL CHIPS ONLY) 8-5
8.4 ECO #: 2992 KRYTOX LUBRICATION CHANGE 8-5
8.5 ECO #: 3288 RESET PULSE CIRCUIT C7 CAPACITOR CHANGE 8-7
8.6 ECO #: 3814 POWER BOARD F35950 C26 CAPACITOR CHANGE 8-8
8.7 ECO #: 3909 DIGITAL BOARD COUNTER/TIMER CHANGE 8-12
8.8 FC2001-46: ALARM ASSEMBLY UPGRADE 8-12
8.9 INSPECTION OF ALARM MODULE F1000711 8-15
8.10 FC2002-06: LOGIC BOARD 35916 8-16
8.11 PLV, RFI ASSEMBLY MOUNTING STUD PROTECTION 8-17

CHAPTER 9: RUN IN
9.0 RUN-IN REQUIREMENTS 9-1
9.1 GUIDELINES 9-1

CHAPTER 10: CALIBRATION AND TESTING
10.0 CALIBRATION 10-1
10.1 INTERNAL AND ALARM BATTERY/CAPACITOR CHARGING AND TEST 10-1
10.2 ZERO REFERENCE SOLENOID VALVE 10-1
10.3 DIAGNOSTIC CHECK 10-2

10.4 DIAGNOSTIC ALARM 10-2
10.5 AC OPERATION 10-2
10.6 TIDAL VOLUME DISPLAY RANGE 10-2
10.7 RATE: PATIENT BPM DISPLAY RANGE 10-2
10.8 INSPIRATORY FLOW RATE DISPLAY RANGE 10-2
10.9 I:E RATIO DISPLAY RANGE 10-3
10.10 INTERNAL BATTERY OPERATION 10-3
10.11 EXTERNAL BATTERY OPERATION 10-3
10.12 LOW VOLTAGE ALARM TEST 10-3
10.13 LOW EXTERNAL BATTERY TEST 10-3
10.14 POWER FAILURE ALARM TEST 10-4
10.15 REVERSE BATTERY TEST 10-4
10.16 POWER BOARD VOLTAGES 10-4
10.17 CHASSIS GROUND TEST 10-5
10.18 UNIT CALIBRATION 10-5
10.19 OUTER LIMIT SWITCH OPERATION CHECK 10-7
10.20 PRESSURE RELIEF VALVE OPERATION CHECK 10-7
10.21 PRESSURE GAUGE CHECK 10-7
10.22 LOW PRESSURE ALARM SETTING CHECK 10-8
10.23 PRESSURE VENT LOW LIMIT 10-8
10.24 PRESSURE VENT HIGH LIMIT 10-8
10.25 CONTROL MODE OPERATION 10-8
10.26 ASSIST CONTROL MODE OPERATION 10-8
10.27 SIMV MODE OPERATION 10-9
10.28 LEAKAGE CURRENT CHECK 10-9
10.29 GROUND RESISTANCE TEST 10-9
10.30 SERVICE REQUIREMENTS 10-10

CHAPTER 11: OPTIONAL ENGINEERING UPDATES
11.0 RECONFIGURING THE RAAS FOR THE PLV-100 11-1
11.1 INSTRUCTIONS FOR CHANGING THE CONNECTOR 11-2
11.2 RAAS INSTALLATION PROCEDURE 11-3
11.3 RELOCATING THE CHECK LEAF VALVE 11-8

CHAPTER 12: THEORY OF OPERATION

12.0 POWER BOARD 35903 ASSEMBLY THEORY OF OPERATION 12-1
12.1 POWER BOARD 35950 ASSEMBLY THEORY OF OPERATION 12-9
12.2 DIGITAL BOARD THEORY OF OPERATION - OVERVIEW 12-17
12.3 AMP AND ZERO BOARD THEORY OF OPERATION - AMP BOARD ASSEMBLY 12-25

CHAPTER 13: PARTS LIST

13.0 ACCESSORIES 13-2
13.1 TOP/BOTTOM/SIDE PANELS 13-3
13.2 FRONT 13-3
13.3 BACK 13-6
13.4 LEFT 13-7
13.5 RIGHT 13-8
13.6 PISTON CYLINDER 13-8
13.7 MISCELLANEOUS 13-10
13.8 AVAILABLE BOARD COMPONENTS 13-11

CHAPTER 14: QA FINAL INSPECTION FORMS AND PROCEDURES

14.0 QA FINAL INSPECTION PROCEDURE - PLV-100 14-5
14.1 USING THE TSI CERTIFIER TO QA PLVS 14-15

CHAPTER 15: SCHEMATICS

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CHAPTER 1 INTRODUCTION

This manual is intended for use when servicing the Respironics® PLV-100. Included in this manual are sections covering troubleshooting, circuit descriptions, and testing. Personnel servicing the PLV-100 should be thoroughly familiar with the PLV-100 Operating Manual and the ventilator's functions. The information contained within this document is subject to change without notice.

This procedure is written for a technician experienced in volt meter usage, soldering, and electrical troubleshooting. **Do not attempt to repair the PLV-100 otherwise.** Unauthorized repair voids the warranty. Refer to the PLV-100 Operating Manual for complete warranty information.

1.0 SERVICING AND WARRANTY

Respironics recommends that the PLV-100 be serviced by Respironics or an authorized Service Center once per year or every 8,000 hours as recorded by the hour meter, whichever comes first. This allows Respironics Service Personnel to check the performance of the unit, check the electrical integrity, and replace parts as necessary.

Respironics warrants the PLV-100 to be free from defects in material and workmanship for a period of one year after delivery, provided that the unit is properly operated under normal conditions. Respironics makes replacements, repairs, or issues credit for equipment or parts which are found to be defective. The defective unit may be returned prepaid to Respironics after the customer has received approval to return the unit.

This warranty does not apply to any unit or individual parts which have been repaired or altered in a way that, in Respironics' judgement, affect its stability or reliability, or which has been subjected to misuse, negligence, abuse, or accident.

This warranty does not cover damage which may occur in shipment. If there is any damage during shipping, please contact the carrier or individual who delivered the unit.

Respironics offers a month-to-month maintenance contract on the PLV-100. The maintenance contract covers all parts, labor, and loaner ventilators.

If a unit is out of warranty, and a maintenance contract is desired, it is necessary for the owner to submit the unit to Respironics or a Respironics distributor for servicing, on a time and material basis, to bring the unit in-line with Respironics standards. The unit can then be placed under a month-to-month maintenance contract.

Respironics®, Inc. has a policy of continued product improvement and reserve the right to alter specifications without notice.

1.1 SERVICE LOCATION

The PLV-100 may be repaired at Respironics Service Centers located throughout most of the world. Please call 800-345-6443 or 724-387-4000 for the location of the Respironics Service Center nearest you.

WARNING
Federal law restricts this device to sale by or on the order of a physician.

1.2 SERVICE AND INSPECTION FORMS

During servicing or inspection of the PLV-100 the following forms and procedures are used:

- PLV-100 QA Final Inspection Form
- QA Final Inspection for PLV-100
- PLV-100 Operating Manual

Copies of these forms can be found in Chapter 2 QA Final Inspection Forms and Procedures.

1.3 RECOMMENDED SERVICE REPAIR, AND TEST EQUIPMENT

Equipment Description	***Manufacturer, Model, and Source***
Test Equipment	
Gate Valve Assembly	*F90902*
Magnehelic Gauge, 0-2 cmH_20	*Use TSI Certifier (1012598) or equivalent*
Magnehelic Gauge, 0-150 cmH_20	
PLV Reverse Battery Assembly	*F90027*
Pressure Restrictor, PLV	*F90037*
Safety Tester	*SI-100 or equivalent [3]*
Multimeter	*Local Supplier [1]*
Connector, 22 mm I.D. Silicone	*FC06348*
Connector, Silicone	*C06341*
Test Lung, 1 liter	*C06658*
PEEP Valve	*C06712*
0-12 Volt Adjustable DC Power Supply	*Local Supplier [1]*
PLV Hose Assembly	*1002358*
Test Gauge, O2, Regulator (PSI)	*F90903*
Printer Cable Assembly (100 plus, 102 and 102b units)	*27019*
Shunt, 1 Meg Ohm (100 plus, 102 and 102b units)	*98265*
Small Arbor Press (use for Faceplate Bushing Press Tool)	*Local Supplier [2]*
Hand Tools and Materials	
Tie Wrap Gun	*Local Supplier [2]*
Torque Driver, Adjustable (2-36 in-lbs)	*Local Supplier [2]*
5/16” socket, 1/4” Drive	*Local Supplier [2]*
Allen Key Set	*Local Supplier [2]*
Nut Driver Set	*Local Supplier [2]*
Soldering Station	*Local Supplier [1]*
Solder Wick, 100” Copper	*Local Supplier [1]*

Wrist Strap, Antistatic	*Local Supplier [1]*
Wrist Cord, Antistatic	*Local Supplier [1]*
Cord, Wrist Strap, Grounding	*Local Supplier [1]*
Mat, Table, Antistatic, 2' x 4'	*Local Supplier [1]*
Pliers, Snap Ring	*Local Supplier [2]*
Heat Gun	*Local Supplier [2]*
Socket Adapter, 1/4", Torque Driver	*Local Supplier [2]*
Wire Cutters	*Local Supplier [2]*
Needle Nose Pliers	*Local Supplier [2]*
Regular Pliers	*Local Supplier [2]*
Straight Blade Screwdriver	*Local Supplier [2]*
Jewelers Screwdriver Set	*Local Supplier [1]*
Philips Head Screwdriver	*Local Supplier [2]*
Wire Strippers	*Local Supplier [2]*
External Retaining Ring Tool	*Local Supplier [2]*
Solder, Pure, 60/40	*Local Supplier [1]*
Jumper Wire with 1K ohm Resistor	*Local Supplier [1]*
Hemostat 6"	*Local Supplier [1]*

Suggested Local Supplier List
[1] Techni-Tool ***Phone 1-800-832-4866***
[2] MSC Industrial Supply Co. ***Phone 1-800-645-7270***
[3] Fluke Biomedical ***Phone 1-800-648-7952***
[4] Newark ***Phone 1-800-463-9275***

1.4 ENGINEERING CHANGE ORDERS

Any ECO not installed in a unit, must be installed during service of the PLV-100, unless it is listed as optional in this service manual. Procedures for incorporating ECOs are found in Chapter 2 of this manual.

1.5 EQUIPMENT INSPECTION

Standard operating procedure requires Respironics Distributors and authorized Service Centers to perform a Final QA Inspection of the PLV-100 after servicing a unit.

It is mandatory that all Respironics service personnel follow the QA Final Inspection for the PLV-100 before the unit is released to a client. These inspection guidelines provide a step-by-step procedure for documenting the results of tests performed on the operation of a PLV-100.

Final QA inspection performed on a PLV-100 includes such criteria as internal and external inspection, diagnostic check, airway pressure, flow and rate check, and shipping configurations. The results, date and inspector's signature are recorded on each inspection form.

Any PLV-100 rejected during finished device inspection, and later reworked or remanufactured, is subject to another complete final inspection.

1.6 AUTHORIZED SERVICE CENTERS

Only those individuals/facilities which attend authorized Respironics Service Training Schools are sold replacement parts. For information on training contact the Technical Services Department at 800-345-6443 or 724-387-4000.

1.7 SERVICING GUIDELINES

Perform the decontamination procedure for returned equipment upon initial receipt of a ventilator from the client or hospital. The decontamination procedure must be completed before beginning service or handling the unit.

If the number of Hours Remaining since the last Preventive Service is GREATER than 6,500 hours, and the unit **is not** being serviced due to a complaint, perform Operational Checks (Chapter 2). If the unit fails Operational Checks, perform the steps in Chapter 2 through Chapter 2.

NOTE

DO NOT *change or replace the Preventive Service Due label behind the filter housing if a Preventive Service is not performed. The number of hours recorded on this label must be maintained for any future service required.*

If the number of Hours Remaining is LESS than 6,500 hours, and the unit **is not** being serviced due to a complaint, perform Operational Checks. If unit passes Operational Checks, perform Preventive Service (Chapter 2) and Calibration (Chapter 2).

If the unit fails Operational Checks, perform the steps in Chapter 2 through Chapter 2.

NOTE

A unit passes Operational Checks if no discrepancy is discovered in unit operation other than volume adjustment, dump valve adjustment, internal battery replacement, pressure relief valve adjustment, gauge replacement, power board voltage adjustments, or other minor repairs or adjustments that do not require disassembly of the unit other than the top and bottom panels of the unit.

If the unit is being serviced due to a complaint, perform Operational Checks to find any other discrepancies with unit operation. The steps in Chapter 2 through Chapter 2, including Preventive Service MUST also be performed, regardless of the number of Hours Remaining.

A unit automatically fails operational checks if a mandatory ECO is not installed.

Refer to Figure 2-1 on the next page for a further description of servicing guidelines.

1.8 SERVICING GUIDELINES

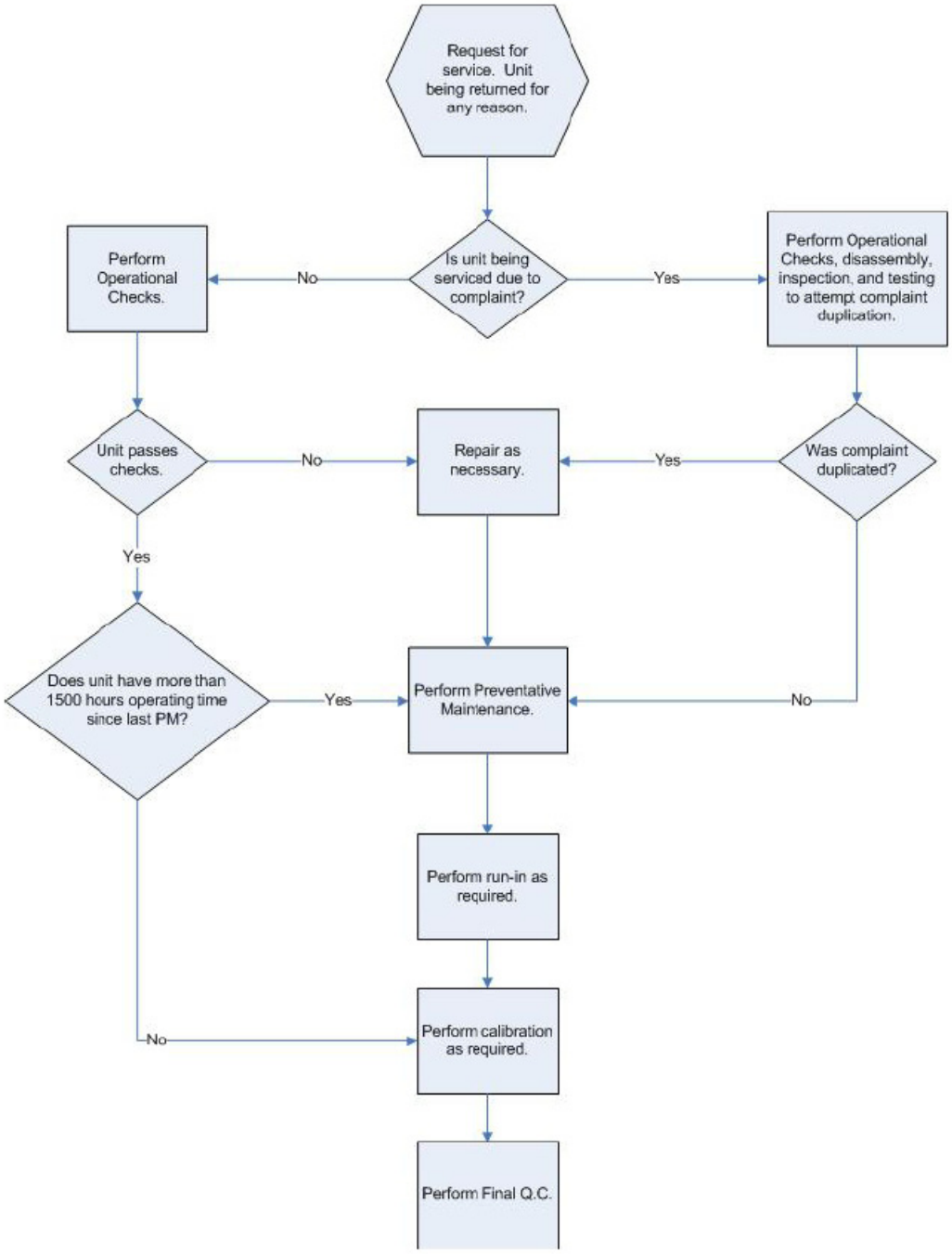

FIGURE 1-1 SERVICING GUIDELINES FLOWCHART

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CHAPTER 2 WARNINGS, CAUTIONS AND NOTES

Warnings, cautions, and notes are used throughout this manual to identify possible safety hazards, conditions that may result in equipment or property damage, and important information that must be considered when performing service and testing procedures. Please read this section carefully before servicing.

WARNING

A WARNING notifies when there is a possible hazard or danger to the Patient or Service Personnel.

CAUTION

A Caution notifies when possible damage may occur to the device.

NOTE

Notes are used to emphasize a characteristic or important consideration.

2.0 WARNINGS

WARNINGS

- *The PLV-100 must be periodically checked and maintained to ensure proper operation.*
- *Connect the PLV-100 to a grounded hospital grade outlet only.*
- *PLV-100 performance may be affected at temperatures below -5°C (23°F) and above 41°C (106°F).*
- *PLV-100 performance may be affected when the internal batteries reach a "low voltage" alarm condition.*
- *DO NOT use the internal batteries in place of external batteries. The internal batteries are for emergency use only.*
- *DO NOT use the PLV-100 in the presence of flammable anesthetics.*
- *Oxygen can be bleed into the PLV-100 by using an O_2 accumulator. DO NOT use oil or grease in or near oxygen equipment or near the PLV-100 ventilator.*
- *DO NOT operate the PLV-100 from the same battery that powers an electric wheelchair. Doing this may reduce the operating time of the PLV-100 from the 12 VDC external power source.*
- *Verify that the alarms are set correctly and are operational.*

2.1 CAUTIONS

CAUTION

- *DO NOT use the PLV-102 to charge an external battery. An external, 10-amp battery charger is recommended. The trickle charge from the PLV-102 is designed only to maintain a fully charged external battery.*
- *Connect the external 12 VDC battery cable as follows:*
  - *WHITE wire to POSITIVE (+) battery terminal.*
  - *BLACK wire to NEGATIVE (-) battery terminal.*
- *DO NOT disconnect an external battery while the unit is operating under load. This may cause the unit to repeat the diagnostic start-up cycle.*
- *Replace the back panel shipping fuse, if needed, with a 5-amp slow blow fuse, type 3AG.*

CAUTION

- *The PLV-100 power transformer is rated between 105 and 130 VAC, 60 Hz, sine wave input. Due to the wide variety of wave forms and voltage produced by inverters, it is recommended that the PLV-100 operate only on a 12 VDC power supply when used in mobile vehicles such as ambulances and aircraft.*
- *The internal batteries may be damaged if the PLV-100 is stored for long periods of time without recharge. For proper internal battery maintenance, the unit must be connected to an appropriate VAC power source for 24 hours at least every three weeks.*

2.2 ESDS CAUTIONS

ESDS CAUTIONS

- *All ESDS items must be stored in approved conductive packaging, tubes, shipping bags, foam or tote bins.*
- *All persons handling ESDS items must be grounded via a 1 Meg ohm resistive grounded wrist strap.*
- *Cover all ESDS bench tops with grounded conductive mats and connect all work surfaces and equipment to earth ground.*
- *Transport all assemblies containing ESDS items in a conductive bag or container.*
- *DO NOT use cellophane adhesive tape to wrap DIP (dual in-line package) tubes together.*
- *DO NOT handle ESDS items by their pins or mix them with other routine electronic parts.*
- *Never place ESDS items on ungrounded surfaces or leave them unattended in an open area.*
- *Avoid cellophane wrappers, synthetic carpeting, warm or cool air blasts, styrofoam coffee cups, etc. when working with ESDS items.*
- *Use only ESD safe solder suckers, grounded soldering irons, and grounded DIP installation tools.*
- *Use only properly designed heat lamps, heat chambers and/or "antistatic" quick-chill sprays during troubleshooting or stress testing procedures.*

ESDS CAUTIONS

- *The following assemblies in the PLV-100 are easily damaged by ESD and require special handling:*
  - *Digital Board (Front Panel Assembly)*
  - *Zero Board (Bulkhead Assembly)*
  - *Power Board (Right Module)*
  - *Amp Board (Back Panel)*

CHAPTER 3 SPECIFICATIONS AND ALARMS

3.0 FRONT PANEL CONTROLS

Mode Selection	*CONTROL, ASSIST/CONTROL, SIMV*
Tidal Volume	*0.05 - 0.20 ± 0.02 liters; 0.20 - 3.00 liters ± 10%*
Breath Rate	*2 to 36 ± 0.5 BPM; 36 to 40 ± 2 BPM*
Inspiratory Flow Rate*	*10 to 120 liters per minute*
Battery Test Switch	*Internal, External Battery*
Main Power Switch	*On, Off/Recharge*
DC Circuit Breaker	*Push-Pull Actuation*
AC Circuit Breaker	*Push-Pull Actuation*
Airway Pressure Limit	*5 to 100 ± 5 cm H2O*
Sensitivity	*+3 to at least -6 cm ± 1 H2O*
Low Pressure Alarm	*2 to 40 ± 2 cm H2O*
Alarm Silence Button	*30 seconds, Automatic Reset*
** Peak flow rate during inspiratory time.*	

3.1 FRONT PANEL VISUAL INDICATORS

Tidal Volume	*Digital Display*
Rate: Patient Breaths Per Minute	*Digital Display*
I:E Ratio	*Digital Display*
Inspiratory Flow Rate	*Digital Display*
Increase Inspiratory Flow*	*Red Indicator Light*
120 (220/240) VAC Power	*Green Indicator Light*
Internal Battery Source	*Amber Indicator Light*
External Battery Source	*Yellow Indicator Light*
Patient Airway Pressure	*-10 to 100 cm H2O*
Assist/Spontaneous	*Green Indicator Light*
15 Second Delay (Low Pressure Alarm	*Green Indicator Light*
*** Flow waveform sinusoidal drive on all breaths.*	

3.2 TEMPERATURE SPECIFICATIONS

Operating Temperature Range	*-5° to + 41°C (+23°F to +106°F)*

3.3 PHYSICAL

Dimensions	*22.9 cm X 31.1 cm x 31.1 cm*
Weight	*12.8 Kg (28.2 lb)*

3.4 OPERATION TIME ON BATTERIES

12 VDC External Battery	*Approximately 24 hrs.*
12 VDC Internal Battery	*Approximately 1 hr.*
Operation time is lessened if conditions causing increased power consumption exist such as extreme settings.	

3.5 BATTERY CHARGING

PLV-100	*Trickle charge to internal and external batteries*
Optional External Chargers	*2 amp charger, 10 amp charger*

3.6 ALARM OR ALERT INDICATORS

Low Pressure	*Visual/Continuous Audible*
High Pressure	*Intermittent Audible*
Apnea	*Visual/Continuous Audible*
Inverse I:E Ratio	*Visual Warning*
Increase Inspiratory Flow	*Visual Warning*
Low Internal Battery	*Visual/Continuous Audible*
Low External Battery	*Visual/Continuous Audible*
Reverse Battery Connection	*Continuous Audible*
Power Failure	*Continuous Audible*
Unit Malfunction	*Intermittent Audible*
Power Source Change	*Audible*
Alarm Silence	*Continuous Visual while activated*

3.7 POWER SOURCES

120 VAC 50/60 HZ	*US, Canada Models*
220/240 VAC 50/60 Hz or 100 VAC 50/60 HZ	*International Models*
12 VDC External Battery	*105 amp hrs Marine Deep cycle recommended*
12 VDC Sources	*Automobile or boat battery by direct connection or using Respironics Auto Lighter Cable*
12 VDC Internal Battery	*Sealed lead acid gel, 2.5 amp hrs.*

NOTE

Throughout the entire Service Manual, "120 VAC 50/60 Hz" shall also imply "220/240 VAC 50/60 Hz or 100 VAC 50/60 Hz" on International models.

3.8 CONNECTIONS FOR 220 OR 240 VAC OPERATION

International model versions of the PLV-100 may be wired to accept 220 or 240 VAC input current. Both operate between 50 and 60 Hz, (see Figure 2-1).

3.8.1 220 VAC OPERATION

Connect the brown lead from the toroid transformer to the white AC lead from the back panel module. The two black wires connect as shown.

3.8.2 240 VAC OPERATION

Connect the white lead from the toroid to the white AC lead from the back panel module. The black wires connect as shown.

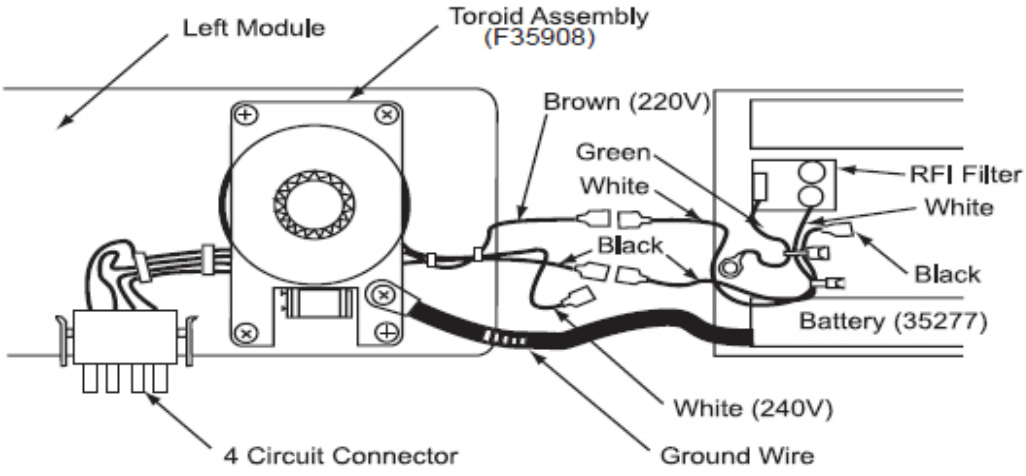

FIGURE 3-1 100 MODULE CONNECTION 220/240 VAC

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CHAPTER 4 TROUBLESHOOTING

The possible causes and actions/solutions listed below are used as guidelines for troubleshooting the PLV-100. This list is NOT complete and other possible causes and solutions should NOT be ruled out. Refer to Theory of Operation and PCB schematics, as needed, to further troubleshoot the PLV-100.

If there is a problem with a certain part of a circuit, check continuity of all traces, and inspect for fractured solder joints.

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
System Start-Up Problems		
1.0 No AC or DC operation.	*1.1 Defective power switch.*	*1.1 Check voltage across **closed** power switch. If voltage is measured, replace power switch.*
	1.2 Broken wires at power switch.	*1.2 Inspect wires at power switch. Replace wires if broken.*
	1.3 Solder joint at switch terminal.	*1.3 Inspect solder joints at power switch. Resolder connections if poor wetting.*
	1.4 Defective DC circuit breaker.	*1.4 Check voltage across **closed** DC circuit breaker. Replace DC circuit breaker if a voltage of ~14 VDC is measured.*
	1.5 Q10 is defective, (power board 35903).	*1.5 Check voltage at TP7, replace Q10 Pin 2 if no voltage is measured.*
	1.6 Q9 is defective, (35903). U2 is defective, (power board 35950).	*1.6 Check voltage at TP8. Replace Q9 or U2 if no voltage is measured.*
	1.7 No continuity or poor in-line connections.	*1.7 Check connections at path of incoming raw power. Repair if connection is poor.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
2.0 No AC operation, but unit operates on DC.	*2.1 Damaged line cord.*	*2.1 Inspect line cord for damage. Replace cord if damaged.*
	2.2 Defective AC circuit breaker.	*2.2 Check voltage across **closed** AC circuit breaker. Replace AC circuit breaker if raw voltage is measured.*
	2.3 Toroid defective.	*2.3 Check Toroid output for 17.8 VAC across RV2.*
	2.4 No power at wall outlet.	*2.4 Plug unit into a different outlet.*
	2.5 Microfuse on power board blown.	*2.5 Inspect fuse. Replace if blown*
	2.6 Q3 is defective, (F35950).	*2.6 Check raw voltage. Check output at Q3, Pin 3. Also check U11.*
3.0 No DC operation, (but unit operates on AC)	*3.1 Back panel fuse open.*	*3.1 Inspect back panel fuse. Replace fuse if open. Check for possible shorts in unit if fuse continues to blow.*
	3.2 Internal battery not charged, or does not hold a charge.	*3.2 Perform battery charging test for 24 hours. After charging the battery check for 14.2 V at TP1. Discard the battery if not.*
	3.3 External battery not charged, or does not hold a charge.	*3.3 Replace the external battery.*
	3.4 CR11 or K1 have failed on power board 35950. K1 or Q7 on power board 35903.	*3.4 Check the voltage at TP1, 4, 5. Replace CR11 or K1 if voltage is present at TP1 or 4, but not TP5. Or K1 or Q7.*
	3.5 Q7 is defective, (35903).	*3.5 Check if Q7 or K1 is open. Replace if defective.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
4.0 Unit switches from AC to DC intermittently	*4.1 Defective power cord.*	*4.1 Measure voltage across the power cord. Replace the cord if the power fluctuates.*
	4.2 Circuit breaker may or may not trip.	*4.2 Reset circuit breaker.*
	4.3 Toroid or RFI is disconnected or has a bad connection.	*4.3 Perform continuity checks on Toroid or RFI circuit. Replace or repair as necessary.*
5.0 Unit continuously runs through diagnostics when plugged into both AC power and connected to the external battery, but runs normally when connected only to AC power or only to the external battery	*5.1 U19 is defective.*	*5.1 Check inputs and outputs on U19. Replace U19 if not in accordance.*
	5.2 CR11 is defective.	*5.2 Check CR11 on power board. Replace if defective.*
6.0 Unit goes through diagnostic, but does not start cycling	*6.1 Amp board cable is disconnected.*	*6.1 Check amp board cable for disconnection.*
	6.2 Oscillator is out of frequency, (F35950).	*6.2 Check TP7 for low voltage. Check analog circuit.*
	6.3 Oscillator is out of frequency, (35903).	*6.3 Check TP8 for low voltage. check analog circuit.*
	6.4 Clock oscillator has a bad signal.	*6.4 Using positive lead of voltmeter or oscilloscope probe Pin 8 of the clock oscillator to check for proper signal.*
7.0 Unit fails to cycle when turned on, and manometer has 2 cmH_2O or greater applied.	*7.1 Disconnected or bad solenoid. Volume window displays 1.0.*	*7.1 Check solenoid. Replace if necessary.*
	7.2 Open wire on harness. Defective transducer, amp board, associated plumbing or circuitry. Volume window displays 1.0.	*7.2 Repair as needed.*
	7.3 Bad op amp (U3).	*7.3 If PX1 or PX10 are both equal, (low voltage), with 40 cm of pressure applied, replace op amp.*
Failure Alarms and LED Indications		

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
8.0 Power source LED does not switch from internal to VAC when connected to an AC power source.	*8.1 Defective multiplexer.*	*8.1 Check U19 on logic board, for a reading of ~4V. Replace as necessary.*
	8.2 No continuity on 50-pin ribbon cable.	*8.2 Check ribbon cable for continuity. Replace cable if there is no continuity.*
	8.3 Various possible causes.	*8.3 Check for AC at AC circuit breaker or low AC.* *Check A to D converter using U27 on the logic board.* *Check TP3 for unregulated or raw voltage.* *Check Pin 3 on power board for a reading of ~20 V.* *Check RP3 Pin 16 on the logic board for a reading of ~20 V.*
9.0 Display LCD segments never turns on or never turns off.	*9.1 Dirty or bad LCD socket contacts.*	*9.1 Check LCD socket contacts. Replace LCD socket or driver chip if bad or dirty.*
10.0 Audible alarm sounds constantly.	*10.1 Unit does not reach set pressure.*	*10.1 Check for internal or external tubing leaks. Replace tubing as necessary.*
	10.2 Logic board switch 1B shorted.	*10.2 Repair short as necessary. Switch in off position is isolated. Replace components associated with a short as necessary.*
	10.3 Q1, 2, or 16 is defective, (35903).	*10.3 Remove alarm battery and check for a voltage of 3.6V.*
	10.4 Q7 or 8 is defective, (F35950).	*10.4 Remove alarm battery and check for a voltage of 3.6V.*
	10.5 CR23 is defective, (35903).	*10.5 Check if CR23 is open. Replace if defective.*
	10.6 TO-3 socket shorting out Q13.	*10.6 Inspect Q13, replace as necessary.*
	10.7 Q1 is shorted from emitter to base, (35903).	*10.7 Check Q1. Replace if shorted.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
11.0 Audible alarm never sounds.	*11.1 Alarm battery is defective, (35903).*	*11.1 Check the voltage at TP6 for a minimum reading of 3.6V. Replace U14 if reading is less. Check the voltage at TP7.*
	11.2 Q8 and Q10 are defective, (F35950).	*11.2 Check the voltage at TP8. Replace Q8 and Q10 as necessary.*
	11.3 Power switch is open.	*11.3 Check the power switch and replace if open*
	11.4 Bad alarm connections or faulty alarm transducer.	*11.4 Check the alarm module and wiring. Replace as necessary.*
12.0 Audible alarm sounds constantly when unit is plugged into AC power source and turned off.	*12.1 Power switch has failed.*	*12.1 Check for continuity and isolation between switching.*
	12.2 Q1 is defective, (F35950).	*12.2 Check Q1, replace if defective.*
	12.3 Q4 is defective, (35903).	*12.3 Check Q4, replace if defective.*
	12.4 Digital board or power board is contaminated.	*12.4 Clean board.*
	12.5 Alarm battery is low.	*12.5 Replace if battery fails alarm battery charging test.*
	12.6 Pressure switch has failed. Volume window displays 1.0.	*12.6 Replace pressure switch.*
	12.7 U8 is defective.	*12.7 Check gain at Pin 1. Check output of U4, Pin 1. Voltage is between 0.78 and 0.92 at null.*
	12.8 50-pin cable is defective.	*12.8 Check cable. Replace if defective.*
13.0 External power source LED is flashing.	*13.1 External power source is low.*	*13.1 Charge or replace external power.*
	13.2 Q7 dual schottky is leaking, (35903).	*13.2 Measure external battery connector. It must read less than 1.5V. Replace Q7 if leaking.*
	13.3 CR11 is leaking, (F35950).	*13.3 Measure external battery connector. Replace CR11 if leaking.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
14.0 Audible alarm sounds and then slowly fades.	*14.1 Trace shows continuity.*	*14.1 Measure infinite resistance on the trace cut when alarm charger board was installed. Recut trace if resistance reading is not infinite.*
	14.2 Defective alarm charger board, (35903).	*14.2 Check alarm charger board. Replace as necessary.*
	14.3 Defective alarm charger PCB, (35903).	*14.3 Replace PCB. A functional board causes voltages at the alarm battery to increase once the alarm starts sounding.*
	14.4 Defective alarm or alarm battery, (35903).	*14.4 Check alarm and alarm battery. Replace as necessary.*
15.0 Alarm volume not loud enough.	*15.1 Low power source.*	*15.1 Check supply voltage. Charge or replace as necessary.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
16.0 Unit stalls and gives intermittent alarm. Unit may or may not restart.	*16.1 Ball screw lacks freedom of movement.*	*16.1 Turn ball screw and check for freedom of movement. Replace the ball screw if it does not move.*
	16.2 Chassis voltage may be out of spec.	*16.2 Check chassis to ground voltage. Troubleshoot as necessary.*
	16.3 Defective motor.	*16.3 Check motor for proper voltage and resistance.*
	16.4 Defective EPROM or microprocessor.	*16.4 Check EPROM and microprocessor for proper signals.*
	16.5 Too much resistance in drive train.	*16.5 Troubleshoot as necessary.*
	16.6 Limit switch wires broken.	*16.6 Check limit switches. Replace if broken. Check voltages at switching.*
	16.7 P2 cable connected backwards.	*16.7 Reconnect cable.*
	16.8 Logic board out of spec.	*16.8 Check motor pulse U8 Pin 6. Check motor circuits on both digital and power boards.*
	16.9 Power board out of spec.	*16.9 Check CR25, 22 (F35950) or CR19, 20 (35903) with an oscilloscope for pull up voltages of 20V. Replace diodes if the pull up voltages are less.*
	16.10 Regulators of FETS shorted to heat sink.	*16.10 Check for shorting. Check for proper isolation between ground plane and components. Replace insulating gaskets as necessary.*
17.0 Unit shows erratic behavior.	*17.1 Defective Limit switches.*	*17.1 Check that the limit switches are normally closed. If not, check wires, crimps, and soldering connections, or repair as necessary.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
	17.2 Defective opto-switch assembly.	*17.2 Check opto-switch output. Output low must be below 0.8 VDC. Output high must be above 3.4 VDC. Replace if voltages are otherwise.*
	17.3 Broken wires in zero board circuitry associated with outer/ inner limit switch or encoder.	*17.3 Repair as necessary.*
18.0 Unit sounds all alarms except low pressure alarm.	*18.1 Alarm battery voltage may be low.*	*18.1 Check alarm battery voltage for a minimum of 3.6V. Repair circuit if the reading is less.*
	18.2 Transducer voltages may be low, (35903).	*18.2 Check the transducer voltages. Pin 1 is 0.79 to 0.92 at null.*
	18.3 R21 (35903) or R36 (35950) is defective, or a wire is broken in the associated circuitry.	*18.3 Replace the resistor or repair wire.*
19.0 Chirping sound coming from the alarm.	*19.1 Short in motor winding.*	*19.1 Replace motor.*
	19.2 Inadequate isolation in gasket under Q7, (35903).	*19.2 Replace gasket. Check for burrs on the heat sink. Resistance must be infinite.*
	19.3 Internal breakdown in Q16, (35903).	*19.3 Replace Q16.*
	19.4 C14 is defective.	*19.4 Replace C14.*
	19.5 Alarm is defective.	*19.5 Replace alarm. Check for oscillating frequency.*
	19.6 C7 is leaking, (35903).	*19.6 Replace C7.*
20.0 No high pressure alarm.	*20.1 Berg jumper in wrong position.*	*20.1 Check that the J1 Berg jumper is removed. Check Q4 and P2 for proper voltage during the alarm mode. Troubleshoot as necessary.*
	20.2 Z2 shorted pulling every thing to ground.	*20.2 Replace Z2.*
21.0 No power loss alarm.	*21.1 Wiring on SW1B.*	*21.1 Check purple and blue wire for proper wiring.*
22.0 No power-on alarm.	*22.1 Broken wires at power switch.*	*22.1 Check power switch and associated circuitry.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
23.0 No alarms.	*23.1 U7 on digital board is defective.*	*23.1 Check U7 and U8 for proper signals.*
	23.2 Q7 has shorted causing a constant alarm silence, (F35950).	*23.2 Check Q7. Replace if shorted.*
24.0 Constant alarm sounds when the unit is on.	*24.1 Alarm battery has a low charge.*	*24.1 Replace alarm battery.*
	24.2 No alarm battery.	*24.2 Check unit for alarm battery. Install battery if none is present.*
	24.3 U8 is defective.	*24.3 Check U8, Pin 10 on the digital board.*
	24.4 D3 on the zero board has shorted or is breaking down under load.	*24.4 Replace D3.*
	24.5 Q1, Q2, Q16 has shorted or is breaking down under load, (35903).	*24.5 Replace as necessary.*
	24.6 Q7 or Q8 has shorted or is breaking down under load, (F35950).	*24.6 Replace as necessary.*
	24.7 No 5-volt digital.	*24.7 Check U2 circuitry, (F35950). Q9, Q10 (35903). Replace as necessary.*
25.0 Unit has a rapid beeping alarm and no LCD displays.	*25.1 EPROM missing or defective.*	*25.1 Check unit for EPROM. Replace as necessary.*
	25.2 Crystal oscillator not working, (U1, 2, 5, 6, 15, 16, 21, 22, 25, 56).	*25.2 Check Pin 8 for proper frequency.*
	25.3 14543 driver chip has shorted.	*25.3 Inspect IC. Replace as necessary.*
26.0 LCD displays flicker during initial turn on.	*26.1 U11 is defective.*	*26.1 Check U11 on the digital board. Check associated circuitry. Repair as necessary.*
27.0 LCDs flash when unit is first turned on.	*27.1 U7 is defective.*	*27.1 Check U7 on the digital board. Check associated circuitry. Repair as necessary.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
28.0 Piston hits limit switch intermittently.	*28.1 Zero board is defective.*	*28.1 Troubleshoot as necessary.*
	28.2 Limit switches are defective.	*28.2 Check for opening and closing of switch. Replace as necessary.*
	28.3 Open or shorted wires.	*28.3 Check bulkhead harness assembly.*
29.0 Piston stalling.	*29.1 U3 is defective. Hex buffers for motor out. Motor shorts out when heated.*	*29.1 Inspect U3. Replace if defective.*
	29.2 U6 is defective.	*29.2 Inspect U6. Replace if defective.*
	29.3 Q14 has shorted.	*29.3 Inspect Q14. Replace if shorted. Check FETs in motor circuit. Ensure proper isolation from heatsink.*
	29.4 Zero board is defective.	*29.4 Troubleshoot as necessary.*
	29.5 Mechanical problem with ball screw.	*29.5 Replace as necessary.*
	29.6 Tightness in piston/cylinder.	*29.6 Adjust as necessary. Replace as required.*
30.0 Piston overdrive to bulkhead or left end panel.	*30.1 Defective outer limit switch.*	*30.1 Check that the outer limit switch is open. Replace if it is closed.*
	30.2 Inner limit switch is defective.	*30.2 Check that the push-button switch is open, with contact. Replace if it is closed.*
	30.3 Opto-switch has failed.	*30.3 Check the opto-switch output. Output low must be below 0.8 VDC. Output high must be above 3.4 VDC. Replace if otherwise.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
31.0 A slight alarm sounds when the piston delivers a breath.	*31.1 Internal batteries are low.*	*31.1 Perform internal battery test. Replace as necessary.*
	31.2 Q1 is leaking.	*31.2 Inspect Q1, replace if leaking.*
	31.3 Ball screw is defective.	*31.3 Replace as necessary.*
	31.4 Piston/cylinder is too tight.	*31.4 Adjust as necessary.*
	31.5 AC voltage is too low.	*31.5 Possible Toroid assembly. Troubleshoot as necessary.*
	31.6 Alarm battery does not hold a charge.	*31.6 Replace alarm battery.*
	31.7 D1 on zero board is leaking.	*31.7 Replace D1.*
	31.8 Internal battery does not hold charge. Low voltage alarm.	*31.8 Allow unit to take a breath over 60 cm pressure. Check TP1 voltage on each breath to make sure it holds charge. Replace batteries if a charge isn't being held.*
Dump Valve Problems		
32.0 Dump valve dumps with every alarm.	*32.1 Purple and gray cable from zero board are interchanged.*	*32.1 Check cable. Switch wires if interchanged.*
33.0 No dump occurring.	*33.1 FET on zero board is blown.*	*33.1 Replace FET.*
	33.2 Pressure switch is mechanically or electrically disconnected.	*33.2 Replace as necessary.*
	33.3 Dump valve wire is broken.	*33.3 If the wire is four inches or more, recrimp. If the wire is less than four inches from contact to dump valve, replace the dump valve.*
	33.4 Internal contamination in valve.	*33.4 Replace the valve.*
	33.5 Vent assembly malfunctioning.	*33.5 Troubleshoot as necessary.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
34.0 Short alarm occurs with dump.	*34.1 Pressure switch is defective.*	*34.1 Replace pressure switch.*
	34.2 Power board.	*34.2 Check dump circuitry and alarm circuitry associated with the dump.*
	34.3 Zero board FET Q4, Cap C2, Diode D2 or D3.	*34.3 Replace as necessary.*
35.0 No alarm when dump valve is activated.	*35.1 CR18 is shorted, (F35950).*	*35.1 Inspect CR18. Replace if shorted.*
36.0 Dump valve functioning intermittently	*36.1 Poor dump valve connector.*	*36.1 Inspect dump valve connector. Replace as necessary.*
	36.2 Defective or loose pressure switch.	*36.2 Inspect pressure switch. Repair or replace as necessary.*
	36.3 Vent assembly malfunctioning.	*36.3 Troubleshoot as necessary.*
37.0 Unit is giving a double dump. (The unit begins the breath with a dump; and again before the breath is complete, the gauge needle falls almost to 0 cm pressure then starts to climb again and triggers another dump). High volume, low rate, or low flow may cause a double dump, but this is normal.	*37.1 Dump transistor Q4 is defective.*	*37.1 Inspect Q4 on zero board. Replace as necessary.*
	37.2 Check C2 and R8 (digital board).	*37.2 Replace as necessary.*
	37.3 Dump valve internally shorting.	*37.3 Replace the dump valve.*

NOTE

Use the following test to identify an electrical vs. mechanical high pressure limit dump problem: Remove the pressure switch and blow on the high side of the switch, or short the contacts with a screwdriver. There is not a problem with the zero board if the dump continues to remain open, (approximately 1.5 seconds), and the alarm sounds for the duration of that time. Replace the dump valve and try again. The dump valve does not work if the vent assembly or pressure switch are not working properly.

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
38.0 U1 (35903) or U13 (F35950) constantly blows out.	*38.1 Zero reference solenoid is defective.*	*38.1 Replace the zero reference solenoid and U1 or U13.*
	38.2 Blue and green wires not connected properly.	*38.2 Check that the connector lines up with the blue wires aligned and the green wires aligned.*
	38.3 Diode on the zero reference solenoid not properly installed.	*38.3 Check the zero reference solenoid for proper installation. Replace diode, do not reuse.*
39.0 Unit runs from inner limit to midpoint, then stalls.	*39.1 Motor winding has a short.*	*39.1 Replace motor.*
	39.2 Problem in motor drive circuit.	*39.2 Troubleshoot as necessary.*
40.0 Unit is resetting intermittently.	*40.1 U24 digital board LS123 is defective.*	*40.1 Replace U24. Check for logic low and logic high.*
	40.2 Frequency drift on clock oscillator is too great.	*40.2 Check for proper frequency coming from U31. Check U30 and U28 if U31 checks out.*
41.0 Low pressure alarm set not consistent with settings.	*41.1 RP2, RP3, and power switch wires are shorted.*	*41.1 Check for shorting causing R-pack to fail.*
	41.2 Bad pot R2.	*41.2 Replace R2, (flow port).*
42.0 Low pressure LED fails to extinguish when manometer reaches low pressure.	*42.1 Pinched hose.*	*42.1 Check unit for pinched hoses.*
43.0 Spontaneous LED fails to trigger when sensitivity knob is set fully counterclockwise and 10 cm pressure, or greater, is applied.	*43.1 RP3 is defective.*	*43.1 Check RP3 for proper resistance.*
	43.2 Power switch wires are shorted.	*43.2 Replace wires.*
	43.3 Pot sensitivity is defective.	*43.3 Replace as necessary.*
	43.4 A to D converter is defective.	*43.4 Replace as necessary.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
44.0 Unit does not initialize when 3 cm pressure is applied to the PAP line and the unit is turned on.	*44.1 Harness is defective.*	*44.1 Replace or repair as necessary.*
	44.2 Zero reference solenoid is defective.	*44.2 Replace solenoid.*
	44.3 Associated wiring and tubing is defective.	*44.3 Replace as necessary.*
	44.4 Sensor vent blocked.	*44.4 Unblock or replace sensor vent.*
	44.5 Associated wiring or tubing to solenoid is bad or reversed.	*44.5 Repair or replace as necessary.*
45.0 Volume delivery not accurate and/or patient outlet is noisy.	*45.1 Leaf in patient outlet needs replacing.*	*45.1 Inspect leaf in patient outlet. Replace as necessary.*
	45.2 Opto-switch is intermittently failing.	*45.2 Check for proper opto-switch signals.*
	45.3 V trim/P trim needs adjusting.	*45.3 Recalibrate the unit.*
46.0 Patient outlet is noisy.	*46.1 Patient outlet leaf and/or baffle needs replacing.*	*46.1 Check for noise during air movement. Replace the leaf valve if flapping occurs. Check that the baffle is properly sealed.*
47.0 No external charging voltage at TP4.	*47.1 U15 is shorted (F35950) Q8 (35903).*	*47.1 Replace U15 and Q8 if shorted or no voltage is present. Check input for proper voltage.*
48.0 No internal battery charging at TP1.	*48.1 U10 is shorted and blown CR21 (F35950) causing the circuit to open. Q6, CR2 (35903).*	*48.1 Inspect U10, CR21 or Q6, CR2. Replace as necessary.*
49.0 Unit does not switch to the external battery.	*49.1 K1 is defective causing the power relay solenoid to short; no voltage at contact solder pads.*	*49.1 Inspect K1. Replace as necessary. Check for fractured solder joints. Check DC receptacle.*
50.0 Cannot trigger a breath in assist control mode.	*50.1 Pressure transducer on amp board (35904) or power board (F35950) is shorted.*	*50.1 Inspect transducer, and replace as necessary.*
51.0 Alarm capacitor does not hold a charge.	*51.1 Capacitor is defective.*	*51.1 Replace capacitor.*

PROBLEM	POSSIBLE CAUSE	ACTION/SOLUTION
52.0 Unit does not calibrate when P trim (R4) is adjusted.	*52.1 Piston ring, leaf checks, or bulkhead gasket is leaking* *52.2 Bulkhead nuts are not tightened.* *52.3 Volume needs to be recalibrated.*	*52.1 Inspect and repair as necessary.* *52.2 Torque nuts to 20" pounds.* *52.3 Check volumes on RT-200A.*
53.0 No voltage at any test points.	*53.1 Fusable trace on power board has blown.*	*53.1 Repair as necessary*
54.0 5 amp fuse blows breaker	*54.1 Breaker may be bad.* *54.2 Dump valve.* *54.3 Power board.*	*54.1 Check/replace 5 amp breaker.* *54.2 Dump Valve.* *54.3 Check/replace power board.*

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CHAPTER 5 OPERATIONAL CHECKS

Operational Checks are used to find any discrepancies that may exist with the operation of the unit. If a unit fails any of these checks, other than a discrepancy requiring minor repairs, the steps in Chapter 2 through Chapter 2 MUST be performed.

5.0 DIAGNOSTIC CHECK

NOTE
If a failure of the alarm is detected, replace the Alarm Module (F1000711) with the latest version (F1000711). (see Section 2.9)

Plug the unit into an AC power supply. Turn on the PLV-100. A five second sequence of automatic, internal, diagnostic checks automatically occurs. This checks the front panel digital displays, the LEDs, the audible alarm, the pressure transducer, the zero reference solenoid, the associated circuits, and the EPROM checksum for proper operation. When performing this check, verify the following:

1. All digital displays (LCDs) read 8s for one second. This confirms the integrity of each digital display (the I:E RATIO display reads 1:8.8 for one second, and then display a fixed number 1: that is always on).
2. Each front panel LED illuminates in the following sequence:
   a. INCREASE INSPIRATORY FLOW
   b. ASS'T/SPONTANEOUS
   c. 15 SEC. DELAY
   d. EXTERNAL BATTERY Power Source
   e. INTERNAL BATTERY Power Source
   f. VAC Power Source
3. The TIDAL VOLUME digital display then reads 0.0. This confirms the integrity of the pressure transducer, the zero reference solenoid, the associated circuits, and the EPROM checksum. Failure of the pressure transducer, the zero reference solenoid, or the associated circuits, causes the TIDAL VOLUME display to read 1.0 and the alarm sounds. If failure of the EPROM checksum occurs, the TIDAL VOLUME display reads 2.0.
4. The audible alarm then sounds to indicate the end of the diagnostic check and confirm that all systems are operable and the unit is functioning normally.

5.1 UNIT START-UP AND AC/DC OPERATION

5.1.1 EQUIPMENT REQUIRED

- 12-volt Adjustable DC Power Supply

5.1.2 PROCEDURE

When connected to an AC power source, unit start-up and operation must be normal. During normal operation the green power source VAC LED is illuminated.

NOTE

On International 100/220/240 VAC units the green power source VAC LED must be illuminated when the unit is plugged into a 100/220/240 VAC power source ***with the unit turned OFF****. When the unit is unplugged from a 100/220/240 VAC power source, the green power source VAC LED must stay illuminated between 5 and 15 seconds.*

On all 120 VAC units the green power source VAC LED **must not light** when the unit is plugged into a 120 VAC power source with the power off.

If the green power source VAC LED is not functioning properly flip the SW-3 switch located on the logic board. This switch indicates a U.S. position or an International position. Check that there is a plastic cap covering the SW-3 switch.

1. Perform the following to check for proper AC/DC operation:
   a. Pull out the VAC circuit breaker. Within six seconds, the power source LED indicates the INTERNAL BATTERY as the power source, and the alarm sounds for three seconds (3-second alarm).
   b. Connect an external 12-volt power source to the EXTERNAL BATTERY 12 VDC outlet on the faceplate module. The power source LED indicates the EXTERNAL BATTERY as the power source, and the 3-second alarm sounds.
   c. Pull out the VDC circuit breaker. The constant power failure alarm sounds.
   d. Push in the circuit breakers to reset, and disconnect the external 12-volt power source.

5.2 POWER BOARD VOLTAGES

5.2.1 EQUIPMENT REQUIRED

- Voltmeter

5.2.2 PROCEDURE

There are two styles of power boards. The earlier version power board (35903) is identified by eight test points along the top edge of the board, (this board is no longer available for order). The later version power board (F35950) is identified by twelve test points along the top edge of the board. Refer to Table 2-1 for voltage specifications for each of the test points.

1. Remove the top panel of the unit to check the voltages on the power board.
2. Using a voltmeter, connect the black lead to ground (TP2) and the red lead to each test point, one at a time, to check specifications.

TEST POINT	VOLTAGE NAME	UNIT	SPEC	ADJUST
TP1	*Internal Charging*	*off/fuse out*	*13.50 - 13.80 VDC*	*R51*
TP2	*Ground*	*plugged in*	*none*	*none*
TP3	*Raw*	*off/plugged in*	*18.0 - 26.0 VDC*	*none*
TP4	*External Charging*	*off*	*13.90 - 14.30 VDC*	*R37*

TEST POINT	VOLTAGE NAME	UNIT	SPEC	ADJUST
TP5	*Line Voltage*	*on*	*13.45 - 14.95 VDC*	*none*
TP6	*Alarm Capacitor*	*off*	*4.50 VDC minimum*	*none*
TP7	*+5 Volt Analog*	*on*	*4.90 - 5.10 VDC*	*none*
TP8	*+5 Volt Digital*	*on*	*4.80 - 5.20 VDC*	*none*
TP9	*+5 Volt Transducer*	*on*	*4.95 - 5.05 VDC*	*none*
TP10	*PX 10 Voltage*	*on*	*2.65 - 2.80 VDC with no pressure*	*none*
TP11	*PX 1 Voltage*	*on*	*2.80 - 2.95 VDC at 25 cm* *1.30 - 1.40 VDC at 0 cm*	*R22* *R23*
TP12	*Dump Circuit*	*on*	*0.80 - 1.0 VDC at 0 cm* *2.50 - 2.70 VDC at 95 cm*	*R2* *R1*
Anode of CR10	*15-volt Regulator*	*on*	*14.25 - 15.75 VDC*	*none*

TABLE 5-1 LATER VERSION POWER BOARD (F35950)

5.3 CHASSIS TO GROUND TEST

5.3.1 EQUIPMENT REQUIRED

- Voltmeter

5.3.2 PROCEDURE

Turn on the unit. Connect the leads from a multimeter to the power board using a 1 Meg ohm shunt. Connect the black lead (negative) to ground (TP2) and the red lead (positive) to the chassis. The multimeter reading must not exceed 1.0 VDC. Turn off the unit, remove the shunt and disconnect the unit from the AC power source. Change the meter to the highest ohms scale (200 KW), the meter must read infinite.

5.4 LOW VOLTAGE ALARM TEST

5.4.1 EQUIPMENT REQUIRED

- Voltmeter
- 12-volt Adjustable DC Power Supply

5.4.2 PROCEDURE

1. Set the operating parameters as follows:
   - Unit = ON
   - MODE = Control
   - TIDAL VOLUME = 1.00 Liters
   - RATE: PATIENT BPM = 2 BPM
   - INSPIRATORY FLOW = 45 LPM
2. Connect a 0-12 volt adjustable DC power supply to the EXTERNAL BATTERY 12 VAC outlet on the faceplate module. Connect the black lead, from a voltmeter, to ground (TP2), and the red lead to line voltage (TP5).

3. Pull the 2 amp circuit breaker. Turn on the unit. Slowly reduce the power supply voltage. The unit starts sounding an alarm at approximately 9.5 VDC, as indicated by the voltmeter. The alarm increases in volume as the volume continues to decrease.

NOTE
Line voltage is pulled down during piston movement. ***Measure the battery voltage when the piston is stationary.***

4. If the unit is not alarming at 9.5 VDC, adjust the alarm pot by turning, R21 on the earlier version power board (35903), or R36 on the later version power board (F35950), clockwise until the unit sounds the alarm at 9.5 VDC. Disconnect the 0-12V adjustable DC Power Supply.

5.5 Alarm Capacitor Test (power board F35950)

Turn on the unit. Pull out the VDC circuit breaker causing the alarm to sound. At the same time, start a stopwatch. The alarm must sound for a minimum of five minutes.

5.6 Tidal Volume Display Range

Make sure both circuit breakers are reset. Plug unit into AC power source. Turn the TIDAL VOLUME knob on the ventilator completely counterclockwise. The unit must display 0.05 liters. Turn the knob completely clockwise. The unit must display 2.99 liters.

5.7 Rate: Patient BPM Display Range

Set the TIDAL VOLUME at 0.40 liters (0.30 liters when testing a 30 BPM PLV-100). Turn the RATE: PATIENT BPM knob completely counterclockwise, and then completely clockwise. The unit must display the range from 2 to 40 BPM ± 2 BPM (from 2 to 30 BPM ± 2 BPM when testing a 30 BPM PLV-100).

5.8 Inspiratory Flow Rate Display Range

Turn the INSPIRATORY FLOW knob completely counterclockwise, and then completely clockwise. The unit must display the range from 10 to 120 LPM.

5.9 I:E Ratio Display range

By adjusting the following knobs: TIDAL VOLUME, RATE: PATIENT BPM, and INSPIRATORY FLOW, check that the I:E RATIO displays a range from 1:0.3 to 1:9.9 LPM.

5.10 Piston/Cylinder Operation

Check that the unit is operating smoothly with no abnormal or excessive noise or chatter.

5.11 Measure Volume Delivery

5.11.1 Equipment Required

- RT-200A or equivalent measuring device
- PEEP Valve

5.11.2 PROCEDURE

1. Set the TIDAL VOLUME to 0.05 liters, the RATE:PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 10 LPM. Connect the hose circuit to the faceplate module of the unit and to a RT-200A, or equivalent measuring device. Measure the total of ten breaths, and divide the total breaths by 10. The volume must be between 0.03 and 0.07 liters. Adjust the P-trim (R4) on the digital board clockwise to increase the volume or counterclockwise to decrease the volume.
2. Set the TIDAL VOLUME to 2.70 liters, the RATE:PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 120 LPM. Measure one breath. The volume must be between 2.43 and 2.97 liters. Adjust the V-trim, R18 on the digital board clockwise to increase the volume, or counterclockwise to decrease the volume. Repeat both the low and high volume delivery checks as necessary to obtain the specified volume delivery.

NOTE

Turn off the unit and then back on after adjusting the V-Trim or P-Trim. This allows the microprocessor to "read" the P-Trim and V-Trim values. If the V or P trim pot setting requires changing, repeat the low and high volume calibrations until both volumes are within specification, as one adjustment affects the other.

5.12 OUTER LIMIT SWITCH OPERATION

5.12.1 EQUIPMENT REQUIRED

- Test circuit

5.12.2 PROCEDURE

1. Attach the test circuit to the patient air outlet. Disconnect the zero board, (located at the base of the bulkhead assembly), cable as identified by the green, yellow, and orange wires. The piston travels past zero and contacts the bulkhead push-button switch, causing the alarm to sound. Reconnect the zero board.
2. Set the Tidal Volume knob clockwise to 2.80 liters. The piston must not actuate the outer limit switch, and an alarm must not sound. Slowly increase the volume. Do not run the turcite nut off the ballscrew. The outer limit switch actuates between 2.81 and 2.95 liters. To prevent damage to the switch do not allow the piston to hit the switch with any force.
3. Adjust the switch, by bending the leaf, to activate between 2.81 and 2.95 liters. There must be no bowing of the left module before the switch activates. Turn the unit off.

5.13 ZERO REFERENCE SOLENOID, PRESSURE GAUGE CHECK

5.13.1 EQUIPMENT REQUIRED

- Test syringe
- Pressure Gauge

5.13.2 PROCEDURE

1. Disconnect the tubing from the front module pressure gauge and connect it to the "tee" on Magnehelic pressure gauge tube. Connect the end of the tube from the Magnehelic pressure gauge to

the front module pressure gauge. Attach a test syringe, (see Table 2-1), to the PAP outlet. A RT-200A or equivalent measuring device may also be used to measure pressures.:

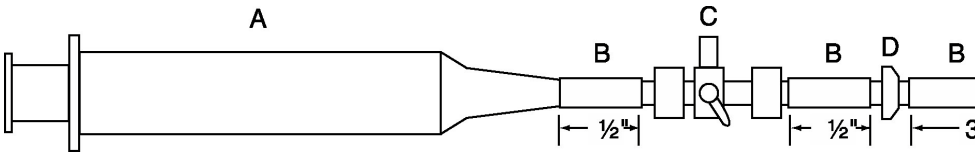


FIGURE 5-1 TEST SYRINGE

A	*Syringe 60 CC*	*98148*	*C*	*Valve Stop Cock*	*98553*
B	*3/16 Inch Tube*	*C06686*	*D*	*Valve Check*	*98554*

(If B, C, and D are not available, use a pair of needle nose pliers to clamp off tubing.)

2. Apply 40 cm of pressure to the PAP assembly using a syringe tool. The reading on the unit pressure gauge must be within 10% of the Magnehelic gauge reading. The pressure in the PAP assembly must not drop more than 6 cm of pressure in 30 seconds. If the pressure does drop more than 6 cm, check the “tee” assembly, the gauge straight connector, or the PAP outlet for leakage.
3. With at least 5 cm pressure still applied to the PAP line, turn on the unit. The unit runs through its diagnostic check and begins breath delivery. If the unit keeps running through the diagnostic check and does not start breath delivery the solenoid valve, the pressure transducer or their associated circuits are malfunctioning and may require replacement or repairs.

5.14 CYLINDER LEAKAGE CHECK

5.14.1 EQUIPMENT REQUIRED

- Test Circuit
- RT-200A
- Gate Valve (F90902)

5.14.2 PROCEDURE

1. Set the TIDAL VOLUME to 1.80 liters, the RATE: PATIENT BMP to 10 BPM, and the INSPIRATORY FLOW to 84 LPM (the I:E ratio reads approximately 1:2.0). Connect an RT-200A, (or equivalent), and gate valve (F90902) to the patient air outlet via a test circuit. Check that the gate valve

is fully open and the peep valve is open (the pressure on PLV-100 gauge must read less than 10 cm). Allow a few breaths for unit to stabilize, then measure the volume of five breaths.

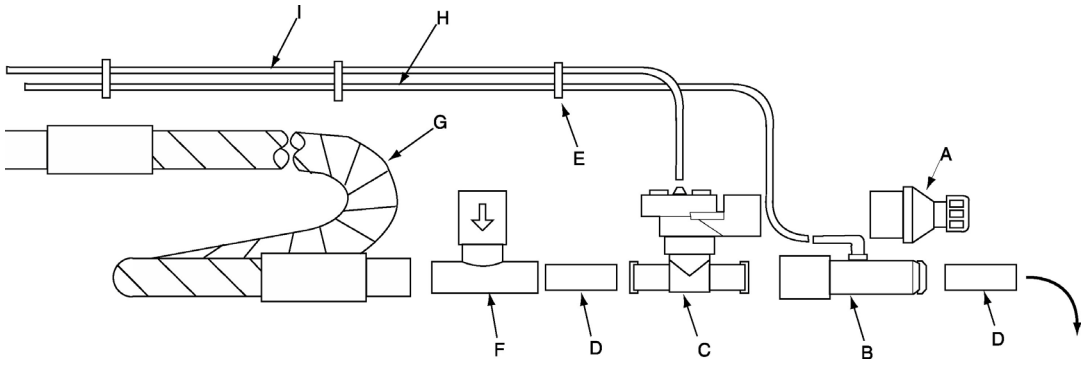


FIGURE 5-2 TEST CIRCUIT

A	*Peep Valve*	*C06712*	*F*	*SIMV Manifold Adapter*	*C06247*
B	*PAP Adapter*	*C06232*	*G*	*24" Clear Hose*	*C06526*
C	*Exhalation Valve*	*C06706*	*H*	*Assist/PAP Line*	*C06686*
D	*Coupler*	*C06348*	*I*	*Exhalation Valve Line*	*C06685*
E	*Hose Clip*	*C06793*			

2. Gradually close the gate valve until the pressure measured on the PLV-100 manometer gauge peaks at 40 cm. Measure the volume of five breaths at 40 cm pressure. Subtract the reading at 40 cm from the reading with no pressure. The difference must be less than 0.35 liters, (0.07 per breath).
3. If the difference is greater, check for leaks around the piston, ball screw, bulkhead, motor, etc. Tighten or replace these parts if necessary, and then retest.

5.15 DUMP VALVE

5.15.1 EQUIPMENT REQUIRED

- RT-200A (or equivalent)
- Test Circuit

5.15.2 PROCEDURE

1. Connect an RT-200A, (or equivalent measuring device), in series with the unit pressure gauge. Set the TIDAL VOLUME to 0.50 liters, the RATE: PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 10-40 LPM.
2. Connect a test circuit with a 1 liter test lung to the patient outlet of the unit.
3. Turn the airway pressure limit knob fully counterclockwise. The dump valve must operate between 0 and 10 cm pressure. If using the TSI Certifier, remove the test lung and add restrictor (1016583). Turn the vent knob fully clockwise. The dump valve must operate between 85 and 105 cm.
4. Refer to Chapter 2, for complete instructions on proper dump valve calibration.

5.16 Pressure Relief Valve Operation

5.16.1 Equipment Required

- Test Circuit
- Test Lung (C06658)
- Pressure Gauge

5.16.2 Procedure

1. Verify a test circuit with a test lung (restrictor if using the TSI) and a Magnehelic gauge (or equivalent gauge capable of reading in excess of 120 cm H_2O) to the PLV-100.

NOTE

Remove and occlude tubing to front panel pressure gauge, otherwise it may become damaged.

2. Unplug the dump valve solenoid from P4 on the power board or use a berg jumper on J1(35950 only). Turn the pressure vent shaft completely clockwise. Turn on the unit, and adjust the operating parameters as follows:
   - MODE = Control
   - TIDAL VOLUME = 0.7
   - RATE: PATIENT BPM = 7 BPM
   - INSPIRATORY FLOW = 10 to 40 LPM
3. Adjust the pressure relief valve if it does not release pressure between 105 cm and 115 cm. Exercise the valve at least one time before reading the pop-off pressure.
4. For units with a Vent Assembly (Figure 2-5), place a finger over the small hole in the vent body, on the side opposite of the pressure switch. This prevents a small air leak. Listen for the pressure relief valve to release the pressure between 105 cm and 115 cm.
5. If the valve does not release the pressure, turn the nut located on the inside of valve clockwise to increase the pressure using a ¼-inch nut driver. To decrease the pressure, turn the nut counterclockwise. Do not turn the nut in either direction more than 360°.
6. Continue to adjust and retest until the pressure relief valve releases pressure between 105 cm and 115 cm. Replace the valve if it still does not release pressure in the proper range.
7. After successful testing of the pressure relief valve, reconnect the dump valve solenoid plug to the power board or remove the berg jumper and reconnect the pressure unit's gauge. (Remove the restrictor, add test lung, and syringe to the PAP line if using the TSI.)

5.17 Assist Control Mode Operation

5.17.1 Equipment Required

- Test Circuit
- Test Lung (C06658)
- Pressure Gauge

5.17.2 PROCEDURE

1. Turn the mode switch to Assist Control. Turn the sensitivity knob completely clockwise causing the unit to auto cycle. The Assist/Spontaneous LED illuminates after every stroke and breath rate increases. The Tidal Volume should be set to 0.5, BPM to 10, I:E Ratio to 1:2.1, and Inspiratory Flow to 25.
2. Slowly close the PEEP valve on the test circuit until the unit stops auto cycling.
3. Slowly open the PEEP valve. The low pressure alarm LED illuminates between 2 and 4 cm H_2O pressure. Fully open the PEEP valve.
4. Gradually reduce sensitivity until the unit stops auto cycling. Add the syringe to the PAP line and squeeze the test lung to simulate a breath. The Assist/Spontaneous LED illuminates at a maximum of -0.50 cm pressure.
5. Turn the sensitivity knob completely counterclockwise. Squeeze the test lung again to simulate a breath. The Assist/Spontaneous LED illuminates at a minimum of -6.0 cm H_2O.
6. Reduce the BPM to 5. Turn the sensitivity knob to approximately the 2 o'clock position. The unit must not auto cycle. Squeeze the test lung every five seconds to simulate a breath. After five breaths the rate reads between 11 and 13 BPM.

5.18 SIMV MODE OPERATION

5.18.1 EQUIPMENT REQUIRED

- Test Circuit
- Test Lung (C06658)
- Pressure Gauge

5.18.2 PROCEDURE

1. Set the mode switch to SIMV. The I:E RATIO displays 1:. Place a Magnehelic gauge in series with the unit pressure gauge. Squeeze the test lung every five seconds to simulate a breath. After five breaths the rate reads between 11 and 13 BPM.
2. Adjust the rate to 2 BPM and the low pressure knob to 20 cm H_2O pressure. The unit alarms within 20 seconds.
3. Remove the test circuit tubing from the PAP outlet and attach a syringe. Place between 18 and 22 cm H_2O pressure on the unit gauge. The unit stops alarming and the low pressure LED turns off within this range. Remove the syringe and reinstall the test circuit tubing. Adjust the low pressure knob to 2 cm H_2O pressure and adjust the operating parameters to Tidal Volume 0.50 liters, 2 BPM, and 10 LPM. Turn off the unit and remove the Magnehelic gauge. Turn the mode switch to control and the sensitivity knob completely clockwise.

5.19 INSPECT POWER SWITCH

Remove the power switch from the faceplate module. Check that the back side of the switch is solid. All switches that do not have solid backs must be replaced with solid back switches. All units which do not have the protective covers over the power switch must have the power switch replaced with one that has the protective cover installed. Reference ECO #2088 to perform power switch replacements.

5.20 Visual Inspection

Visually inspect the external surfaces of the PLV-100 for scratches or cracks in the case. Replace the top, bottom, and side panels as necessary.

5.21 Inspect for ECOs

Verify that all mandatory ECOs are installed. If an ECO is missing, the unit automatically fails operational checks. For a listing of ECOs refer to Chapter 2.

5.22 Leakage Current Check

5.22.1 Equipment Required

- SI-100 Leakage Tester

5.22.2 Procedure

With the leakage tester turned off, connect the AC plug to the leakage receptacle on the SI-100 leakage tester. Turn on the tester. Readings in “forward” and “reverse” must not exceed 100 micro amps.

5.23 Ground Resistance Test

5.23.1 Equipment Required

- SI-100 Leakage Tester

5.23.2 Procedure

With the SI-100 leakage tester turned off, connect the AC plug to the resistance receptacle on the tester. Turn on the tester. Probe all metal areas on the outside of the ventilator. The highest reading must not exceed 0.1 ohm. Turn off tester and remove AC plug.

CHAPTER 6 PREVENTIVE SERVICE

The following preventive service procedures are followed each time a PLV-100 is serviced. Preventive Service is performed once per year or every 8,000 hours according to the hour meter.

NOTE

The following Preventive Service procedures MUST be followed each time a PLV-100 ventilator is serviced unless the number of hours remaining since the last preventive service is greater than 6,500 hours and the unit is not being service due to a consumer complaint.

6.0 PREVENTIVE SERVICE PROCEDURES

Chapter 2 provides detailed information on performing these preventive procedures.

- Replace or clean the PATIENT AIR INLET and MACHINE AIR VENT filters found on the back panel.
- Replace the Krytox lubricant in the ball screw/silent block assembly.

NOTE

The new Krytox (1061274 and 1061273) can be used with the new Armoloy Ball Screw (see Figure 2-19) and the old Carbon Steel Ball Screw but first you must remove as much of the original Krytox (1061272 or 1061271) as possible from the old Carbon Steel Ball Screw. The original Krytox (1061272 or 1061271) should not be used with the new Armoloy Ball Screw.

- Replace the seal spring (35465).
- Clean the baffle and replace the check valve leaf(s) (33440) in the patient intake port on the bulkhead, and in the patient outlet.

NOTE

For earlier versions of the PLV-100, the bulkhead must be removed prior to replacing the check valve leaf in the patient intake port. Refer to Relocating the Inlet Check Valve Leaf (Chapter 2) for more information.

- Clean or replace all interior pneumatic tubing, as necessary.
- Replace internal batteries (35277), every 12 months or every 8000 hours recorded on the hour meter, whichever comes first.

NOTE

New battery packs have a shelf life of 18 months. Ensure that the new battery pack has not exceeded its shelf life.

- Replace PLV Power Switch at each routine maintenance interval or anytime service is being performed on the device.
- Replace damaged items of a cosmetic nature, as necessary.
- Check the O-rings under the knobs on the faceplate module for rotting, replace as necessary.
- Replace the motor (F35062) at 30,000 hours ± 2,000 hours. Refer to 2.1 Motor Change Requirements for more detailed information.

NOTE

The motor is not included in the cost of Preventive Service for customer owned equipment.

- Check the power board voltages, and adjust as necessary.
- Test the low voltage alarm, and adjust as necessary.
- Check the relief valve, and adjust as necessary.
- Check the dump valve, and adjust as necessary.

NOTE

The Electronic Dump Valve should be replaced every 24 months or 16,000 hours. When replacing the dump valve record the replacement date and machine hours on the PLV Dump Valve Label contained in kit 1006621.

- Check the TIDAL VOLUME, and adjust as necessary.
- Perform the chassis to ground test.
- Perform the ground leakage test.
- Replace any items damaged due to abuse or misuse such as; impact, liquid spills, battery acid spills, etc., as necessary.

6.1 MOTOR CHANGE REQUIREMENTS

The original motors (35036), with a black and silver label and a copper-layered armature were installed in the PLV-100 from 1984 through 1988. Their maximum useful service life was determined to be 10,000 units as recorded on the PLV power meter.

In August 1988, an improved motor (F35062) with a black and yellow label and a nickel-plated armature became available. This motor, is being used in all PLVs today. It provides an expected average service life of up to a maximum of 30,000 hours. As with all electromechanical devices, the expected service life is an average figure, not an absolute number. Since 1988, the label used on these motors has been various different colors. Any motor that does not have a black and silver label is the most current improved motor.

In June 1988, PLV-100s changed from using **power meters**, to show accumulated motor power usage, to actual time **hour meters**. Hour meters were installed in all units manufactured after July 1988, and are retrofitted into earlier units using ECO #2073 in Chapter 2 of this Service Procedure as a routine engineering update.

6.1.1 MOTOR WARRANTY AND CHANGE OUT

The following is a brief summary of the current Respironics® motor warranty and Preventive Service change-out policy.

The original copper-layered armature motors (35036) with the black and silver labels should be changed out by this time, as they have exceeded their maximum 10,000 power meter reading.

The copper-layered armature motor change applies to all PLV ventilators with serial numbers beginning with 84, 85, 86, 87, and 88, that have a motor with a black and silver label.

The current motor (F35062), with the nickel plated armature and any colored label besides black and silver must be changed by 30,000 hours, as indicated on the **hour meter.** The hour meter must not be confused with the originally installed **power meters** which recorded only accumulated power units applied to the motor during use.

The Respironics® warranty on any new PLV ventilator, including its motor or other components, is one year regardless of the number of hours on the motor or the hour meter.

Service Representatives must carefully screen all units submitted for service and:

a. Ensure that any Respironics® rental unit has had the proper motor replacement, especially any unit found to still contain the original copper-layered armature motor with the black and silver label.
b. Strongly recommend to the client or user that the appropriate motor change be made according to the guidelines in this procedure.
c. If the owner of a unit refuses to have the motor changed, refer to Company Bulletin #921037 (Domestic USA), or #921036 (International) for the proper procedure on how to document a client/owner refusal to have the ventilator motor changed. The information and procedures in these Company Bulletins must be followed, and the proper refusal letters must be signed by the client/owner and then filed in the Device History Record for that ventilator.

6.2 PLV POWER SWITCH REPLACEMENT PROCEDURE

The PLV Power Switch (1004888) is to be replaced at each annually scheduled preventative maintenance interval.

For example:

- If a PLV is returned to your facility for annual preventive maintenance the power switch should be replaced as a part of the preventive maintenance and it should be replaced every year as part of the annual preventive maintenance.
- If that same PLV is returned due to a failure in the field within the annual preventive maintenance period and the repair is made without extending the current annual preventive maintenance period the power switch does not need replaced.
- If you are extending the annual preventive maintenance period out one year from the date of the repair then the power switch must be replaced.

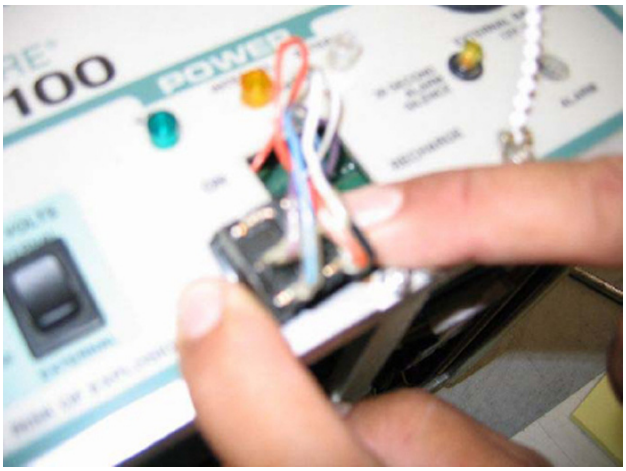
6.2.1 FOR DEVICES WITH THE POWER SWITCH MOUNTED TO THE BOARD

1. Remove the molex connector from the board.
2. Remove the Power Switch from the Device
3. Install the new power switch by connecting the Molex connector to the board.

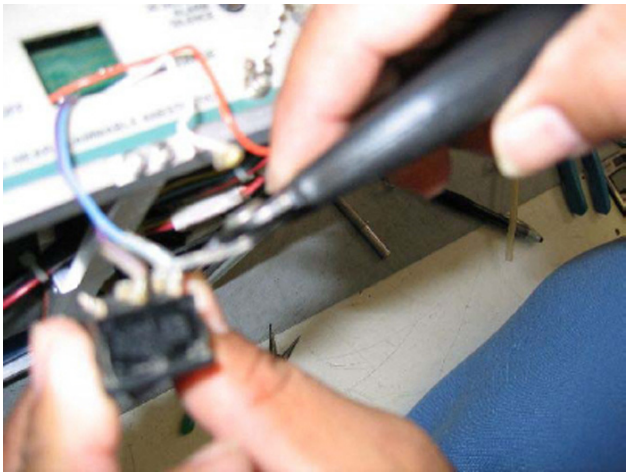
6.2.2 For Devices with the Power Switch Hard Wired to the Board

6.2.2.1 Option 1

1. Remove the switch cover.
2. Materials required: flux, solder braid, 1/8 inch clear shrink tubing, new power switch, new switch cover, soldering iron, 62/37 solder, flush cutters, needle-nose pliers, appropriate flux solvent, a small cleaning brush or pad.
3. Remove the old switch from the front panel. Note the placement of the wires.



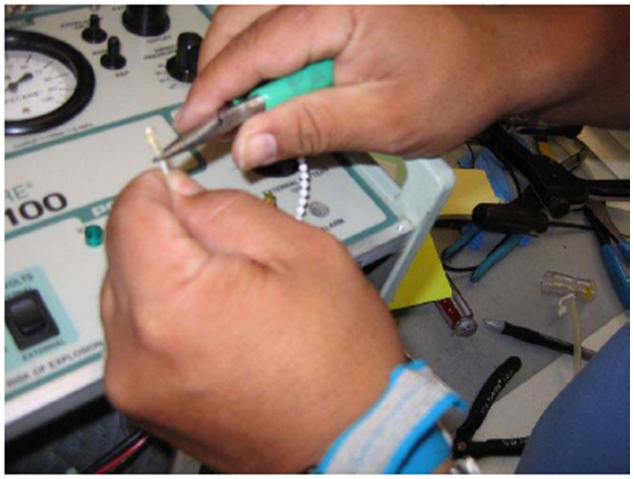
4. Remove the wires by cutting with flush-cutting diagonal pliers close to the switch terminals.



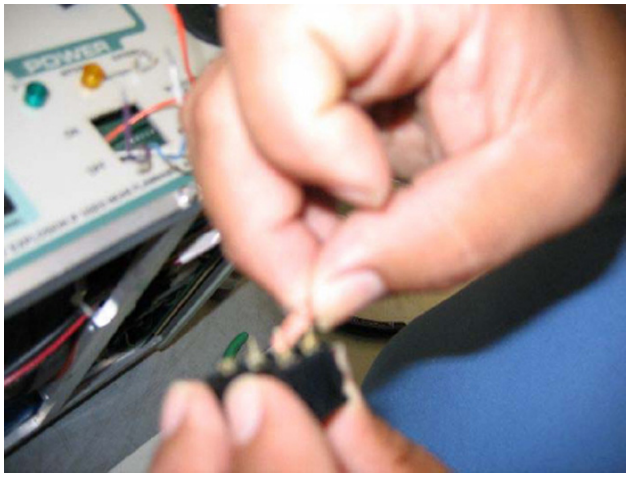
5. Remove the old shrink tube.
6. Strip 3/16” of the insulation from the wires.

7. Tin the exposed wire, taking care not to damage the insulation.

8. Slide a 3/4” section of 1/8” clear shrink tubing over each wire, far enough down the wires to protect them from the heat of soldering.



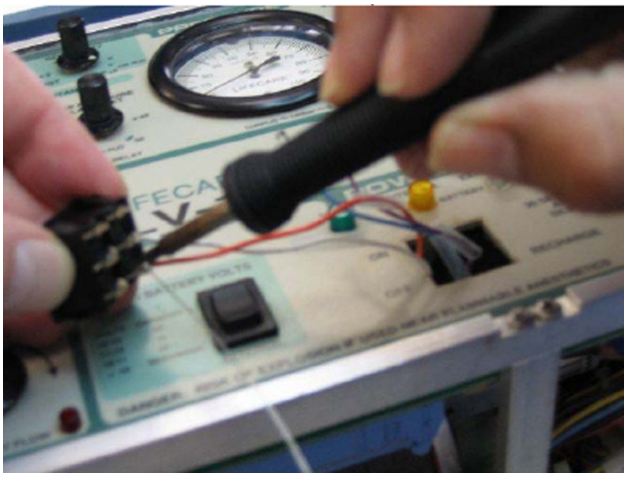
9. Bend the tinned wire ends into a ‘U’.
10. Clean the terminals of the new switch using solder braid or other appropriate brightening agent.



11. Bend 4 switch terminals, the two in the center position and two on one end of the switch.

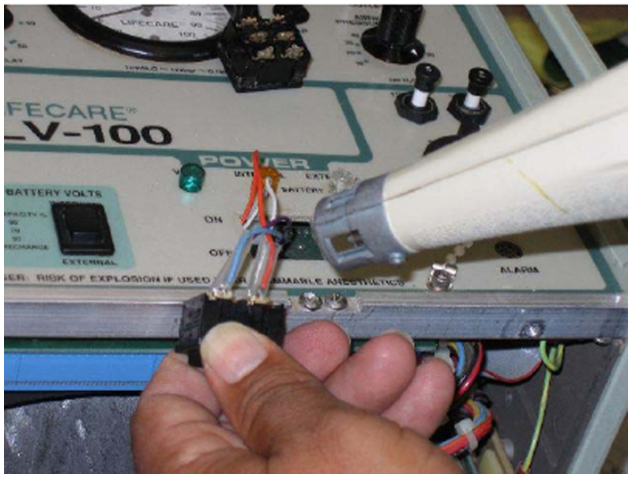
12. Using flush cutters, trim the projecting pins from the remaining terminals.

13. Lightly flux the bent, tinned wire ends and the bent terminal ends.
14. Hook the wires into the appropriate switch contacts and solder in place. Insure wires are trimmed to the appropriate length (just flush with the inside of the switch terminal 'U' bend) prior to applying the heat and solder.

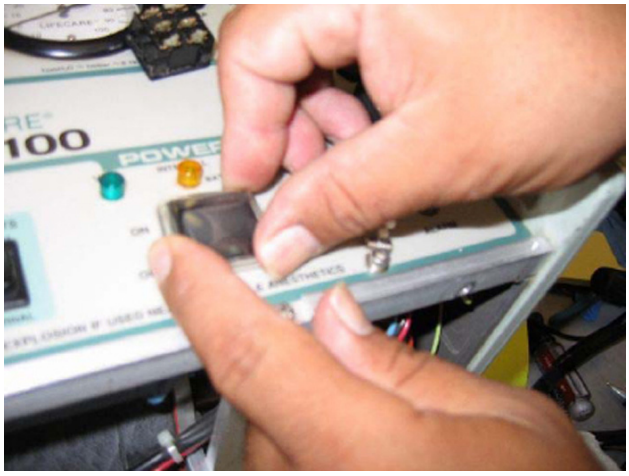


15. Using appropriate flux solvent and a small brush or cleaning pad, clean the solder joints to remove flux residue.
16. Inspect the joints to be certain they are bright, with no voids or signs of a cold joint. The fillet should be smooth, with neither too much nor too little solder.

17. Slide the shrink wrap into place over the joints and apply just enough heat with a heat gun to shrink it firmly into place.



18. After cooling, insert the switch back into the front panel of the PLV unit and install a new switch cover.

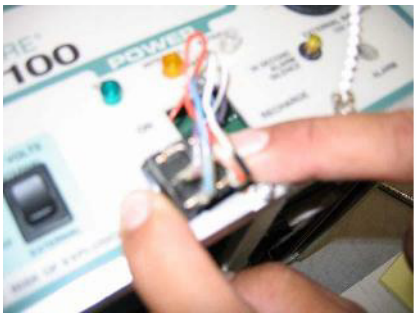


19. Test the switch operation. The unit should turn on and go through self test when the switch is closed. The alarm should be audible immediately upon switch closure.

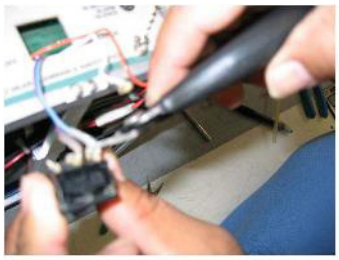
6.2.2.2 OPTION 2

1. Remove the power from the unit by unplugging the AC cord and removing the 5A fuse from the rear of the unit.
2. Remove the old power switch cover.

3. Remove the old switch from the front panel.



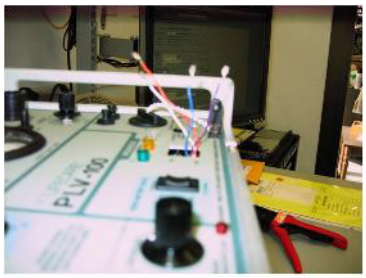
4. Remove the wires by cutting with flush-cutting diagonal pliers 1/16” behind the insulation.



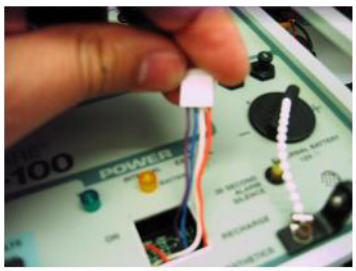
5. Remove the old heat shrink tubing.
6. Strip 1/16” of the insulation from the wires.

CAUTION
Be sure there is no solder on the end of the wires. Placing a crimp terminal on tinned wire will stiffen the wire and hinder flexibility causing the wire to break with movement. Any solder wires will decrease the reliability of the crimp.

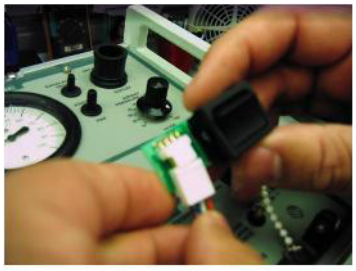
7. Place a crimp terminal (F38300) over the exposed wire and fasten with crimpers.



8. Place the crimped wires in the Molex connector (38377) in order.



9. Install the new power switch by connecting the Molex connector to the board and installing the new switch assembly on the face plate along with the switch cover.



10. Test the switch by turning the unit on. The unit should go through self test when the switch is closed. The alarm should be audible immediately upon switch closure.

6.3 ECOs

Install all applicable ECOs, including those listed below. Refer to Chapter 2, Engineering Change Orders, for detailed installation instructions.

Mandatory Engineering Change Orders (ECOs)

ECO #1156	*18 Segment to 128 Segment Encoder*
ECO #2073	*Hour Meter Installation*
ECO #2088	*Installation of Capacitor Auxiliary Board, Power Switch Change, and Cover Installation*
ECO #2730	*Watchdog Timer Resistor Change to 127K ohm*
ECO #2876	*Multiplexer U19 Change (National chips only)*
ECO #2992	*Krytox Lubrication Change*
ECO #3288	*Reset Pulse Circuit C7 Capacitor Change*
ECO #3814	*Power Board 35950 C26 Capacitor Change*
ECO #3909	*Digital Board Counter/Timer (U28) Change*
FC 2001-46	*Alarm Assembly Upgrade*

NOTE

For optional engineering updates, refer to Chapter 2

CHAPTER 7 DISASSEMBLY, INSPECTION, AND REASSEMBLY

The following instructions describe how to disassemble, inspect, and reassemble the PLV-100.

CAUTION

Observe all antistatic precautions before handling printed circuit boards. Refer to Antistatic Control Procedures for information concerning the handling of static sensitive parts. All persons handling static sensitive parts must be grounded via a 1 Meg Ohm resistive grounded wrist strap.

7.0 REMOVE THE TOP, BOTTOM, AND SIDE PANELS

7.0.1 EQUIPMENT REQUIRED

- Phillips Screwdriver

7.0.2 PROCEDURE

1. Remove the side panels by unscrewing the four 8-32 screws found in each panel. Remove the top panel by unscrewing the two screws found in the back edge of the panel.
2. Remove the bottom panel by first positioning the unit on its back, and removing the four rubber feet from the bottom of the unit. Pull the bottom of the panel forward slightly and lift upward to disengage it from the front lip of the unit.

WARNING

Always disconnect the AC and DC power sources from the unit when working with or disassembling modules. Use caution when lowering modules to prevent damage or stress to external surfaces, internal wiring, and tubing.

7.1 LOWER THE LEFT MODULE

7.1.1 EQUIPMENT REQUIRED

- Phillips Screwdriver

7.1.2 PROCEDURE

Remove the four 6-32 screws from the left module. Observe the position and routing of the electrical wires for reassembly later. Lay the left module down on the work surface, using care not to stress electrical wiring.

7.2 REPLACING THE TOROID ASSEMBLY

7.2.1 EQUIPMENT REQUIRED

- Phillips Screwdriver

7.2.2 PROCEDURE

1. If the Toroid assembly is not operating properly, disconnect the 4-pin male connector (35298) and the two smaller male and female connectors.
2. Remove the four 8-32 screws from the transformer plate (35418) and remove the assembly (see Figure 2-1).

NOTE

A bridge rectifier CR1 and a 12K µF filter capacitor are located under the transformer plate, next to the transformer (see Chapter 2 for detailed power board schematics).

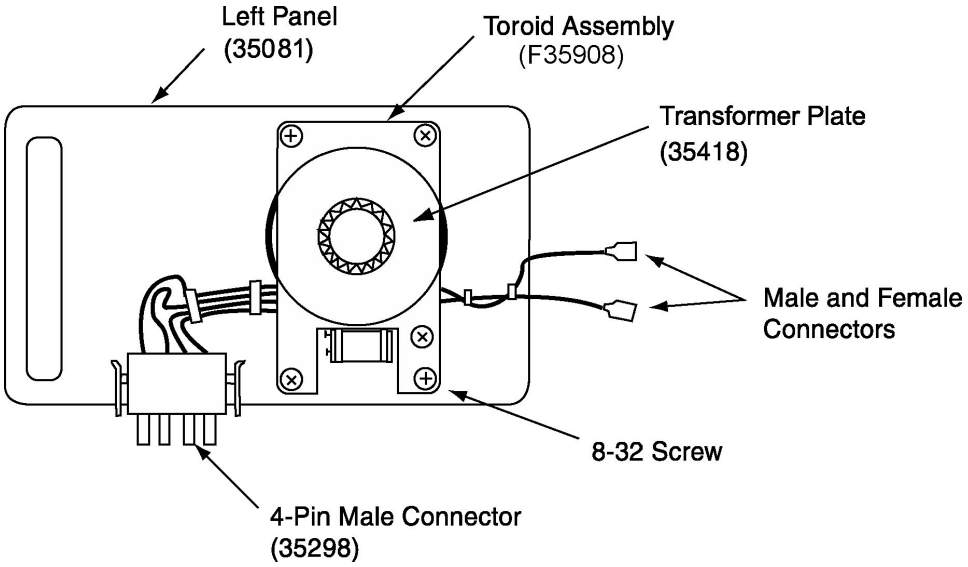


FIGURE 7-1 LEFT MODULE (120 V)

7.3 LOWER THE RIGHT MODULE

7.3.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Voltmeter

7.3.2 PROCEDURE

1. The right module contains the power board and the heat sink. Figure 2-2 shows the power board and heat sink being removed from the right module.

NOTE

The right module may be lowered, but not completely removed from the unit without lowering the faceplate module first. Before completely removing the right module, remove the screws from the upper and lower ties rods and disconnect the blue ribbon (P3) from the digital board.

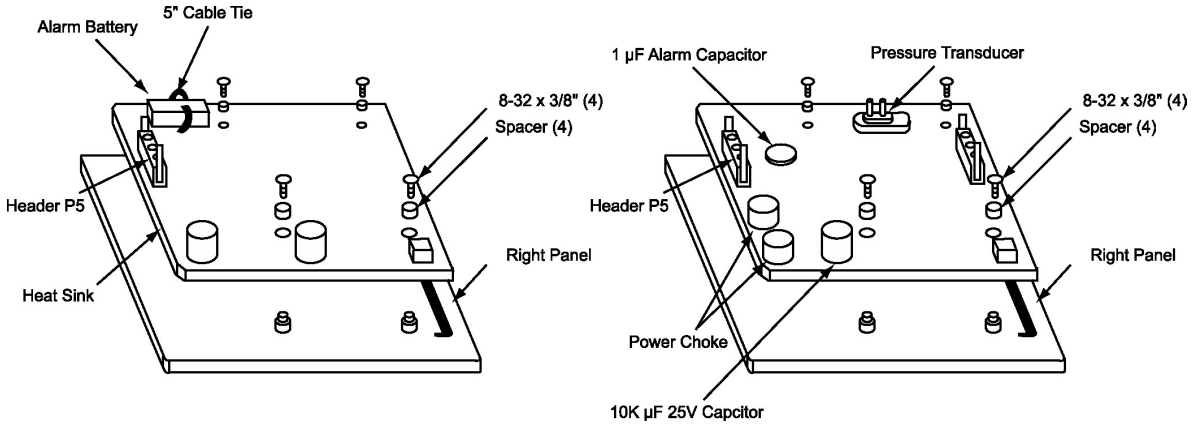


FIGURE 7-2 RIGHT MODULE

7.3.2.1 FOR UNITS WITH POWER BOARD F35950

1. Lower the right module by removing the four 6-32 screws in the module. Disconnect the two hoses connected to the pressure transducer.
2. Disconnect the 14-pin ribbon cable, P5, and the 4-pin ribbon cable, P1. Disconnect the 3-pin ribbon cable, P2. Lower the right module onto the work surface, using care not to stress the electrical wiring.

NOTE

Power board F35950 uses a 1 F alarm capacitor, and does not have an alarm battery.

7.3.2.2 REPLACING THE TO-3 PACKAGE

1. If the TO-3 package on the power board heat sink is not operating properly, replace it by removing the power board from the right panel. Figure 2-3 shows the heat sink and power board after it is removed from the right panel and turned over to access the TO-3 package.
2. Unscrew the two 6-32 screws, and remove the TO-3 package. When replacing the TO-3 package, ensure the insulator (35069) is installed as shown in Figure 2-3. Using an ohm meter, test the TO-3 package to ensure that it is completely isolated from ground. It may be necessary to add a second insulator between the TO-3 regulator and the heatsink.

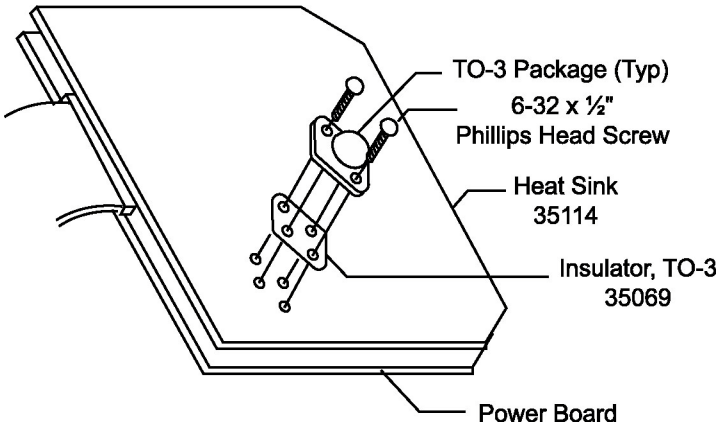


FIGURE 7-3 TO-3 PACKAGE ON POWER BOARD HEAT SINK

7.4 LOWER THE FACEPLATE MODULE

7.4.1 EQUIPMENT REQUIRED

- Philips Screwdriver

7.4.2 PROCEDURE

1. Unscrew the two 6-32 screws from the upper tie rod and the two 6-32 screws from the lower tie rod. Spread the side connectors to release the blue ribbon AMP board cable (P3) from the top of the digital board.
2. Disconnect the ¼-inch OD clear tube that connects the EXHALATION VALVE fitting to the bulkhead cylinder by gently pulling it away from the bulkhead cylinder fitting.
3. Disconnect the ¼-inch OD clear tube that connects the zero reference solenoid (on the back module) to the ASSIST/PAP fitting and front panel pressure gauge. Disconnect this tubing at the tee.
4. Move the faceplate module to the right to allow the patient elbow, to slide off the patient outlet Figure 2-4.

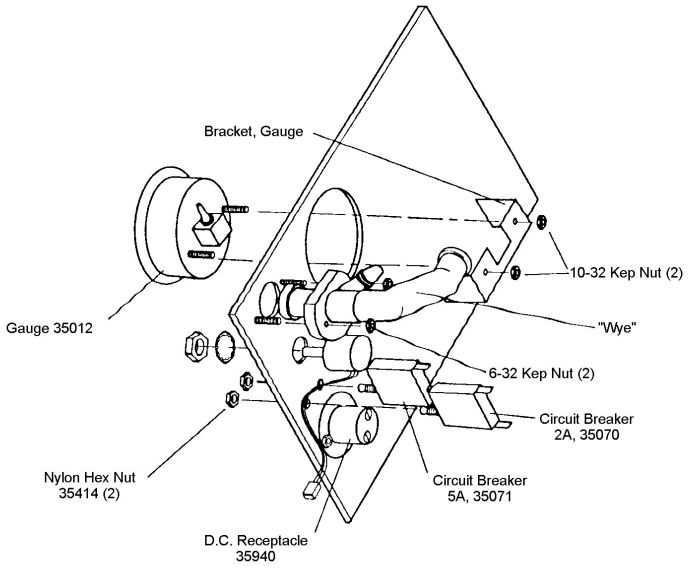


FIGURE 7-4 FACEPLATE MODULE

5. Carefully lower the faceplate module onto the work surface. Ensure that the lower tie rod does not scratch or damage the faceplate and use care not to stress the electrical wiring or components. Inspect all tubing for secure connections and any indication of possible crimping when the unit is in operational configuration. Replace any tubing that appears soiled, aged, or collapsed.

7.5 REMOVAL OF THE DIGITAL BOARD

7.5.1 EQUIPMENT REQUIRED

- Allen Wrench
- Pliers
- Soldering Equipment

7.5.2 PROCEDURE

1. Remove the MODE, TIDAL VOLUME, RATE: PATIENT BPM, INSPIRATORY FLOW, LOW PRESSURE ALARM SET, AND SENSITIVITY knobs from the front of the faceplate, by loosening the set screws.
2. Remove the nuts and O-Rings found under the knobs. Check the O-Rings under the knobs for dry-rot, and replace any that are cracked or broken.
3. Unscrew the nut from the 30-second alarm silence button, if installed. Carefully lay the front module on the work surface, and remove the three 6-32 nylon nuts which secure the digital board to the back of the faceplate.
4. Desolder the three wires that connect the battery switch, and the four wires that connect the ON/OFF switch to the digital board. Desolder these wires at the switch end. Disconnect cables P1 and P2 and carefully lift the digital board off the faceplate module.

5. Inspect the digital board for integrity. All components must be secure in their sockets. Reconnect the battery switch and the ON/OFF switch. Reconnect the digital board and reassemble the faceplate module.

7.6 REMOVAL OF THE VENT ASSEMBLY

7.6.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Alien Wrench
- External Retaining Ring Tool

7.6.2 PROCEDURE

1. Earlier models have a vent assembly. The vent assembly (See Figure 2-5) was replaced by an electronic dump valve in units with the later version power board (F35950). If the unit has an electronic dump valve installed skip to Electronic Dump Valve Service.
2. Remove the AIRWAY PRESSURE LIMIT INCREASE knob from the front of the faceplate module. Remove the outer snap ring (C02490) from the front of the vent shaft (35055) using an external retaining ring tool. Do not reuse the snap ring after it is removed from the vent shaft. These rings are designed to be used only once, and then replaced with a new one.
3. Remove the vent bushing (35054) and flat washer (35462) from the front of the shaft. Gently remove the pressure switch (35119) from the vent body (35072). Exerting pressure on the switch may cause it to break off in the vent body.
4. Loosen the two 4-40 x ¼ PHMS screws in the vent body and slide the vent assembly away from the rear of the faceplate. For easier access to the two 4-40 x ¼ PHMS screws remove the VAC circuit breaker from the faceplate module.

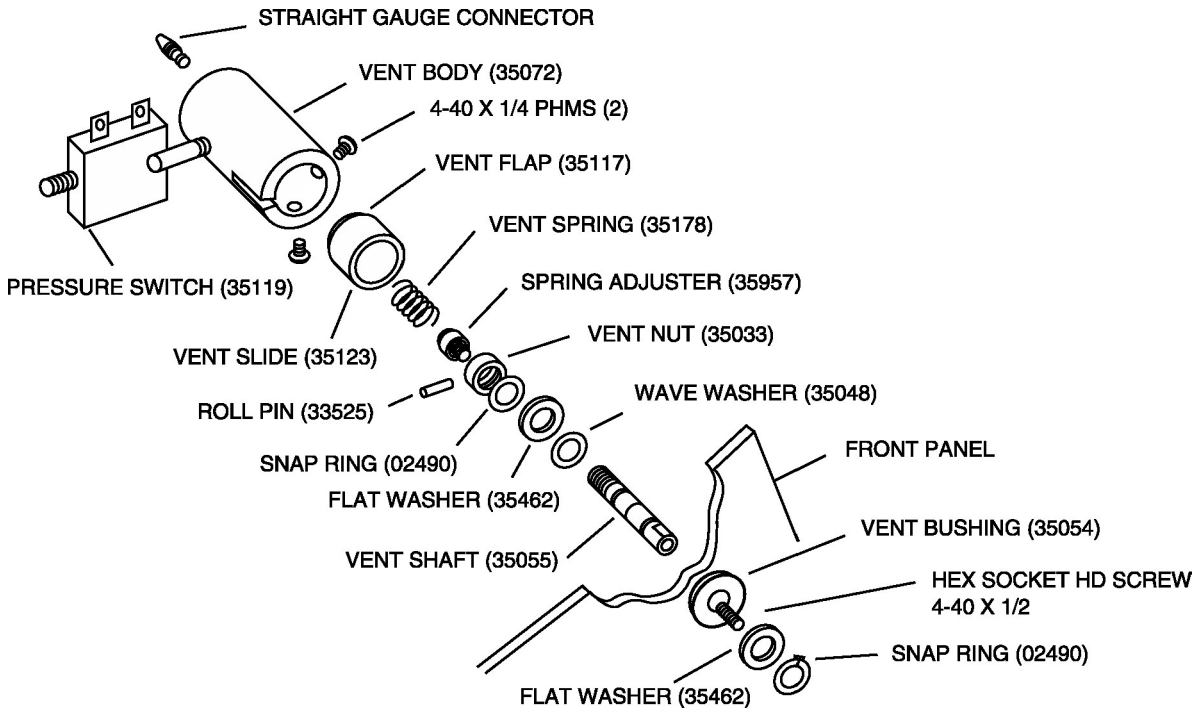


FIGURE 7-5 VENT ASSEMBLY

5. Remove the inner snap ring (C02490), flat washer (35462), and wave washer (35048), being careful not to lose the vent spring (35178). Check the vent slide (35123) for freedom of movement. Hold the vent body vertical and allow gravity to move the vent slide, rotate the vent body 180° for each slide movement. Repeat, as necessary, to ensure proper slide movement.
6. If the vent slide does not move freely, clean the surfaces of the vent slide and vent body with a mild detergent or cleaner. **DO NOT SAND**. It may be necessary to remove a burr around the screw holes of the vent body.
7. When changing vent assemblies, it may be necessary to replace the vent bushing (35054) to allow for a proper fit of the vent shaft. Some vent assembly interior parts may be new style parts.
8. Reassemble the vent assembly in the reverse order of the above procedures.

7.7 CALIBRATE AIRWAY PRESSURE LIMIT

7.7.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Test circuit
- RT-200A or equivalent measuring device
- #20 Allen Wrench

7.7.2 PROCEDURE

NOTE

The pressure relief valve must be tested prior to calibration of the airway pressure limit. Refer to Chapter 2 for complete instructions on testing the pressure relief valve.

1. Connect a patient circuit to the front panel of the PLV-100. Attach a test lung and peep valve to the patient circuit. Tee the RT-200A (or equivalent pressure measuring device capable of reading pressures in excess of 120 cmH_2O) into the PAP line tubing in series with the unit pressure gauge, (see Figure 2-6).

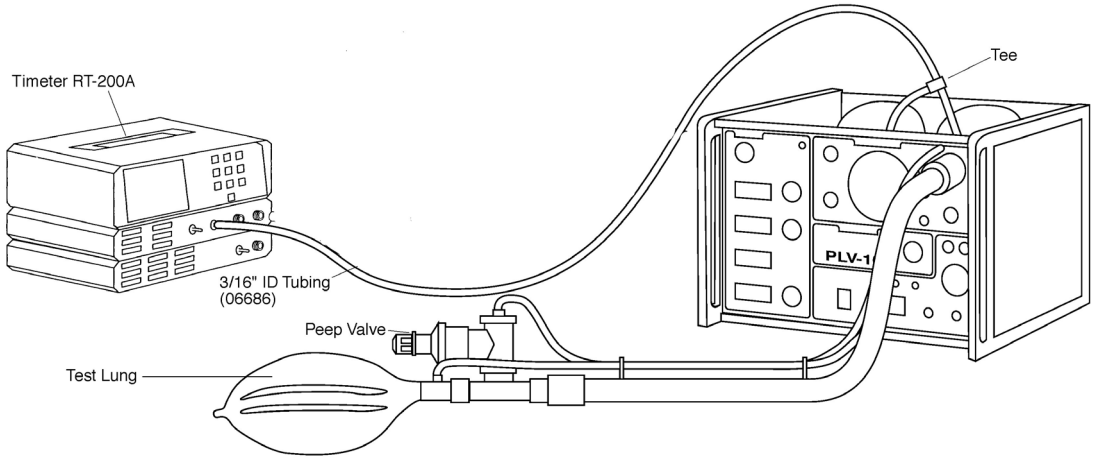


FIGURE 7-6 UNIT SETUP FOR AIRWAY PRESSURE LIMIT CALIBRATION

2. Adjust the unit to the following operating parameters:
   - MODE = control
   - TIDAL VOLUME = 0.50 liters
   - RATE: PATIENT BPM = 10 BPM
   - INSPIRATORY FLOW = 10 LPM
3. Turn the AIRWAY PRESSURE LOW LIMIT knob completely counterclockwise. The vent assembly must operate between 0 and 10 cm H_2O pressure as read on the RT-200A or equivalent measuring device.
4. Test the airway pressure high limit. Turn the AIRWAY PRESSURE LOW LIMIT knob completely clockwise. The vent assembly must operate between 85 and 105 cm H_2O as read on the RT-200A or equivalent measuring device.

NOTE

Adjust the TIDAL VOLUME to reach the desired pressure.

7.7.2.1 LOW LIMIT TEST FAILURE

Perform the following operation for a vent assembly that does not operate below 10 cm H_2O during the low limit test:

1. Turn off the unit and disconnect the AC and DC power sources. Lower the faceplate module. Loosen the two 4-40 x ¼ PHMS screws in the vent body. Space the vent body approximately 1.0 mm away from the faceplate module and retighten the screws. Reassemble the faceplate module.

2. Repeat the airway pressure low limit test as previously described. The vent assembly must operate between 0 and 10 cm H_2O pressure.

NOTE

If the dump valve still does not operate below 10 cm H_2O *pressure repeat the above steps, spacing the vent body an additional 1.0 mm away from the faceplate each time, to a maximum of 3.0 mm.*

3. If the unit continues to fail when the vent body is 3.0 mm away from the faceplate, replace the vent spring (35178), and repeat the airway pressure low limit test.

7.7.2.2 High Limit Test Failure

Perform the following operation for a vent assembly that operates below 85 cmH_2O during the high limit test.

1. Remove the Allen head screw (98354) from the vent shaft using a #20 Allen wrench. Turn the vent shaft counterclockwise 2 or 3°. Hold the vent shaft to prevent it from turning. Turn the spring adjuster screw, located inside the vent shaft, with a #20 Allen wrench clockwise to INCREASE the pressure before the vent assembly operates.
2. Remove the Allen wrench and turn the vent shaft clockwise. Check that the vent assembly operates between 85 and 105 cm H_2O. If not, repeat the above step until the desired results are achieved. Install the Allen head screw into the vent shaft after testing.
3. Recheck the airway pressure low limit to ensure that the vent assembly still operates below 10 cm H_2O pressure, then recheck the airway pressure high limit to ensure the dump valve dumps between 85 and 105 cm H_2O pressure.

Perform the following operation for a vent assembly that operates above 105 cmH_2O during the high limit test.

1. Remove the Allen head screw from inside the vent shaft using a #20 Allen wrench. Turn the vent shaft clockwise 2 or 3°. Hold the vent shaft to prevent it from turning. Turn the spring adjuster screw, located inside the vent shaft with #20 Allen wrench counterclockwise to DECREASE the pressure before the vent assembly operates.
2. Remove the Allen wrench and turn the vent shaft counterclockwise. Check that the vent assembly operates between 85 and 105 cm H_2O pressure. If not, repeat the above step until desired results are achieved. Install the Allen head screw into the vent shaft after testing.
3. Recheck the airway pressure low limit to ensure that the vent assembly still operates below 10 cm H_2O pressure, then recheck the airway pressure high limit to ensure the vent assembly operates between 85 and 105 cm H_2O pressure.

7.8 Electronic Dump Service (power board F35950)

The electronic dump circuit replaces the mechanical vent assembly in newer PLV-100s. The vent assembly that was mounted to the front panel is replaced with a potentiometer with a limit to limit output voltage proportional from 5 cm H_2O to 100 cm H_2O as read on the front panel pressure manometer.

Electronic dump valves are not to be disassembled or cleaned for any reason. Disassembling and cleaning of the dump valve, solenoid, plunger, or other associated dump valve parts only enhances the possibility that dirt, debris, or other foreign matter to cause improper operation of the dump valve assembly. Clean dirty electronic dump valves externally only with alcohol. Replace dump valves that are reported to have stuck open.

NOTE

The Electronic Dump Valve should be replaced every 24 months or 16,000 hours. When replacing the dump valve record the replacement date and machine hours on the PLV Dump Valve Label contained in kit 1006621.

Vent assemblies that are found to be dirty inside may be removed from the cylinder bulkhead of the ventilator, and cleaned using alcohol and a Q-tip or lintless towel. Clean the inside barrel and the seat of the vent assembly in the same manner. Use alcohol to clean the slide and pad. Burrs or scratches may be smoothed using a fine-grit emery cloth. Use alcohol to clean these parts after using the emery cloth.

7.9 Calibrate Airway Pressure Limit (electronic dump and power board f35930)

7.9.1 Equipment Required

- RT-200A
- Voltmeter
- Test Circuit

7.9.2 Procedure

1. Connect the RT-200A or equivalent to the unit. Turn the airway pressure limit knob, on the face-plate module of the PLV-100, completely clockwise.
2. Adjust R1 on the power board until the voltage at TP12 is between 2.50 and 2.70 VDC. Turn the airway pressure limit knob on the front panel completely counterclockwise. Adjust R2 on the power board until the voltage at TP12 is between 0.80 and 1.00 VDC. The unit must dump at a maximum pressure of 10 cm, and the alarm must sound.
3. Turn the airway pressure limit knob on the front panel clockwise. Connect a test circuit with a 1 liter test lung to the unit. While constricting the test lung increase the unit pressure until the dump valve activates. The unit dumps between 85 and 105 cm pressure and an alarm sounds. Adjust R1 and R2 on the power board, as necessary, to achieve proper operation.

7.10 Remove Patient Outlet Assembly (Version 1)

7.10.1 Equipment Required

- 5/16” Nut Driver
- 600 Grit Wet/Dry Sandpaper

7.10.2 Procedure

1. Lower the faceplate module as previously described. Remove the two 6-32 KEP nuts that secure the outlet to the front panel using a 5/16 -inch nut driver. Separate the patient outlet assembly from the faceplate.
2. Inspect the patient outlet snaplock for sharp edges that could cause plastic shavings to form inside the patient circuit. If the outlet is cutting the tubing of the circuit, use a narrow strip of 600 grit wet/dry sandpaper and polish the edges of the patient outlet. After polishing, the edges may still feel

sharp, but should not feel jagged. Clean the outlet with a dampened paper towel to reveal any sharp/jagged edges.

3. Remove the leaf and baffle assembly. To change the check valve leaf, remove the old leaf from the baffle.
4. There are two faces of the baffle. One face is slightly recessed, forming a “lip”. The baffle MUST be installed in the same position as shown in Figure 2-7

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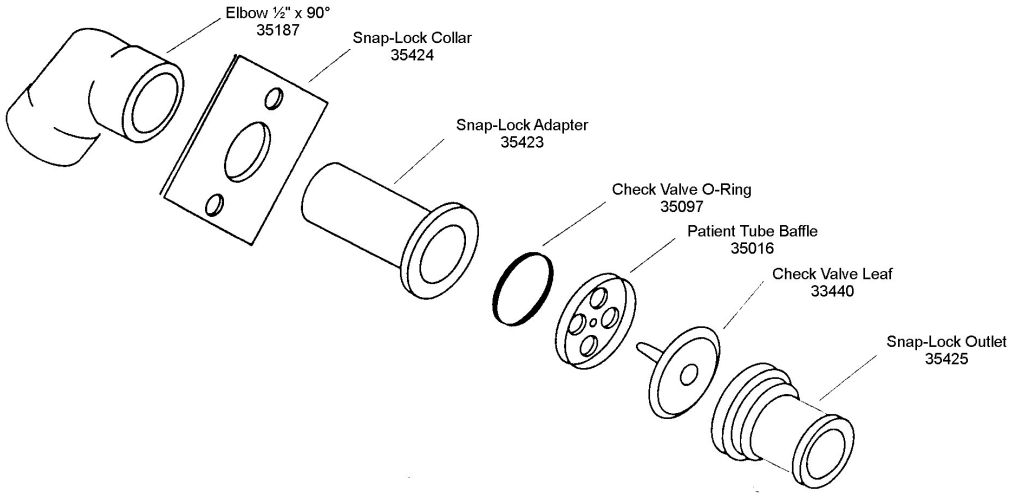


FIGURE 7-7 PATIENT OUTLET ASSEMBLY (VERSION 1)

5. Insert the “tail” of the leaf into the center hole of the baffle. Pull the tail of the leaf through the baffle until it “snaps” into place.

7.11 REMOVE PATIENT OUTLET ASSEMBLY (VERSION 2)

7.11.1 EQUIPMENT REQUIRED

- 5/16” Nut Driver

7.11.2 PROCEDURE

1. The service procedure for Version 2 of the patient outlet assembly is similar to that for Version 1. Lower the faceplate module and remove the two 6-32 kep nuts that secure the outlet in place.

NOTE
Older models with a metal outlet include a rubber check valve gasket.

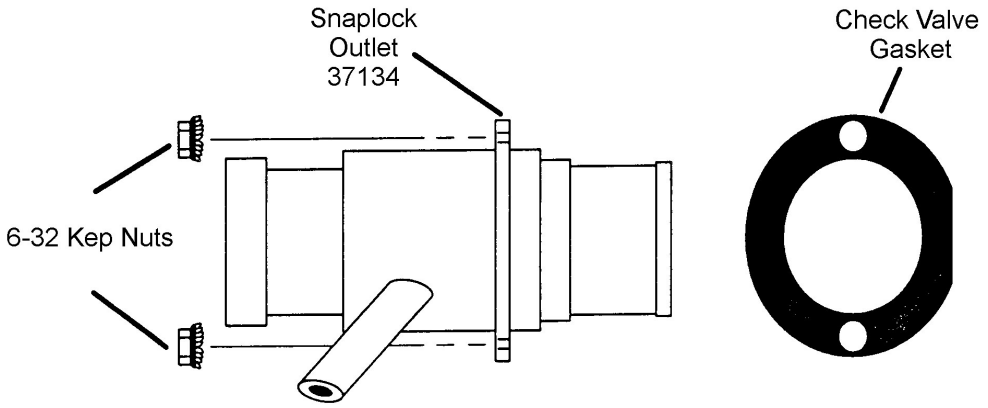


FIGURE 7-8 PATIENT OUTLET ASSEMBLY (VERSION 2)

2. Remove the patient outlet assembly from the faceplate. Remove the leaf and baffle assembly from inside the elbow.
3. To change the leaf, first remove the old leaf from the baffle. Observe the difference in the two faces of the baffle. One face is slightly recessed, forming a “lip”. The baffle must be reinstalled in the same position as shown in Figure 2-7. Install the check valve with the leaf resting on the lip of the baffle.
4. Insert the “tail” of the leaf into the center hole of the baffle. Pull the tail of the leaf through the baffle until it “snaps” into place. After installing the leaf into the baffle, trim the excess tail of the leaf valve.

7.12 REMOVE BACK MODULE

7.12.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Machinist’s File

7.12.2 PROCEDURE

1. Disconnect the unit from the AC power source and remove the top and bottom panels as previously explained. Lower the left and right modules. Remove the screws that secure the back module to the top and bottom cross braces.

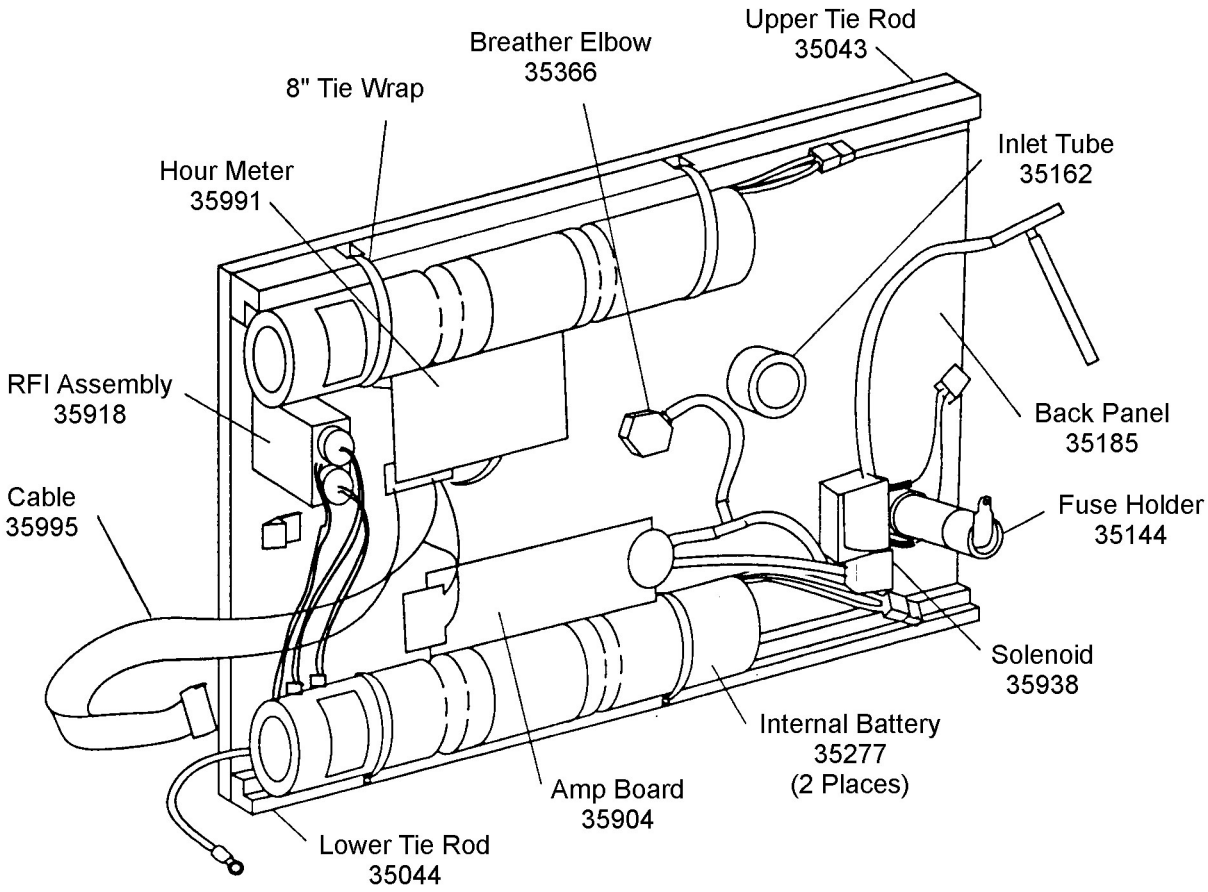


FIGURE 7-9 BACK PANEL FOR POWER BOARD 35903

2. If the PLV-100 has an AMP board which is now obsolete, disconnect the AMP board's blue ribbon connector at the top rear of the digital board (P3). Disconnect the ¼-inch OD tubing from the PAP connector. Carefully lay the module onto the work surface, being careful not to stress the cables or tubing.
3. Inspect the internal battery tie wrap grooves on the back panel tie rods (four total) and verify that the edges have been smoothed. If not use the edge of a standard machinists' file to file down the tie rod as not cut into the battery tie wraps.
4. Inspect all wiring and cables for wear, crimping and secure connections. Replace the wire or cable if any signs of wear or abrasion are observed.

7.13 REASSEMBLE BACK PANEL

1. Install new clear tubing between the transducer and zero reference solenoid (see Figure 2-10). Tighten a 3-inch cable tie around all tubing connections to prevent air leakage. Reassembly is in the reverse order of removal.

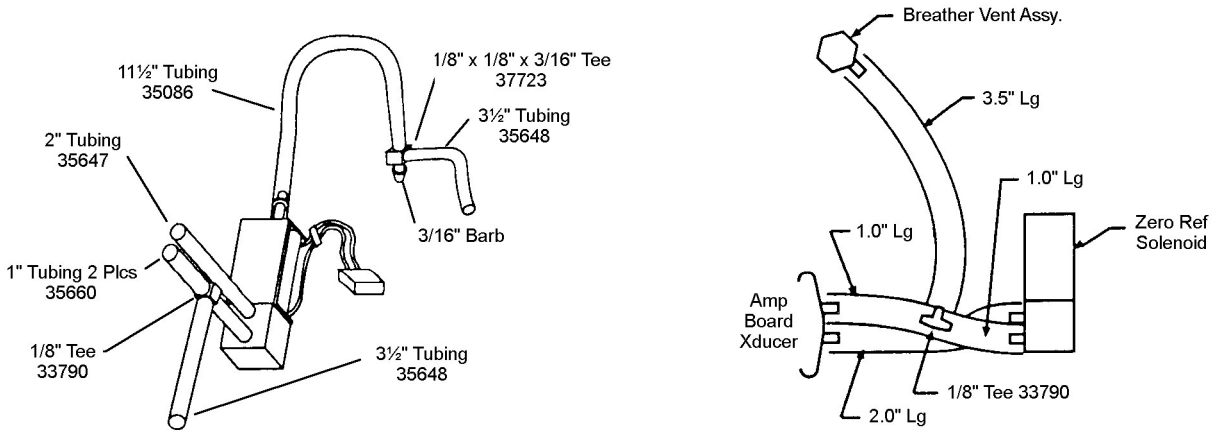


FIGURE 7-10 TUBING CONFIGURATIONS

2. Either configuration is acceptable. Replace the 35903 configuration with the F35950 if repairs are required. Cut the hoses off lengthwise and remove from the transducer outlets to prevent damage to the transducer.

7.14 REMOVAL OF THE MOTOR ASSEMBLY

7.14.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Allen Wrench
- Torque Wrench

7.14.2 PROCEDURE

1. Unplug the Opto-switch cable and two motor leads, (see Figure 2-11). With the left module lowered, turn the ball screw clockwise. This moves the piston to the left end of the cylinder.

CAUTION

Do not run the ball nut assembly off the end of the ball screw.

2. Remove the four 8-32 screws from the motor plate. Pull the motor away from the bulkhead, supporting its weight the entire time.
3. Loosen the set screw using an Allen wrench and disconnect the coupler ONLY from the ball screw, (leave the coupler attached to the motor at this time). Inspect the coupler and replace if there is any indication of wear.
4. The PLV-100 motor is a sealed unit and cannot be disassembled for repair. Attempted repair of the motor voids the unit's warranty.

5. Replacement of the motor assembly is the reverse order of the removal procedures. It is recommended to replace the motor AFTER the bulkhead, cylinder and piston have been reassembled. Secure the coupler to the ball screw to a torque of 17-inch pounds.
6. Check that no wires or tubing are caught between the motor and bulkhead. Check that all attachment screws (especially those that connect the coupler to the ball screw) are properly tightened. Secure the motor to the bulkhead assembly to the specified torque of 20-inch pounds.

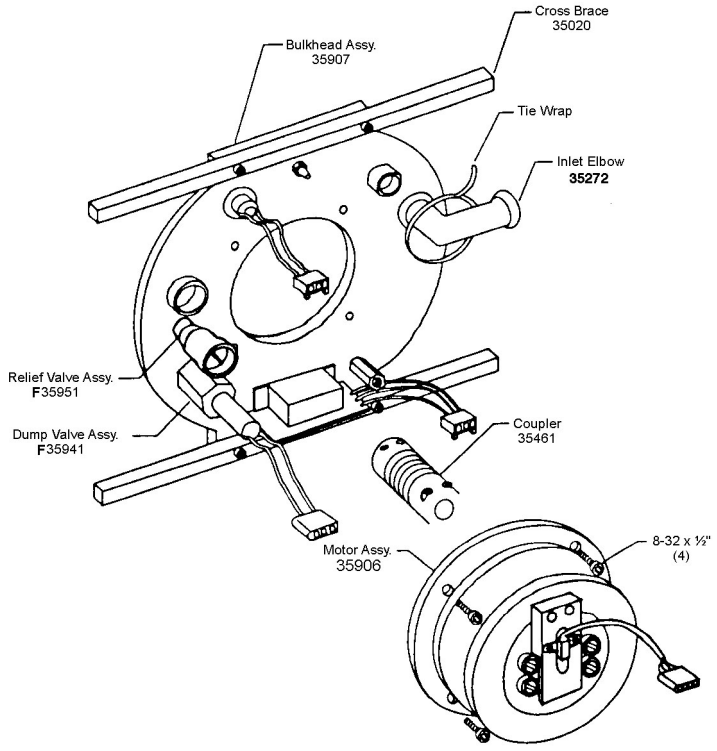


FIGURE 7-11 MOTOR ASSEMBLY

7.15 RELOCATING THE CHECK LEAF VALVE

7.15.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Allen Wrench

7.15.2 PROCEDURE

1. Remove the Motor Assembly as described in the previous section.

2. Remove the six nuts that secure the bulkhead assembly to the cylinder. Separate the bulkhead from the cylinder. Remove the leaf valve from the bulkhead.

CAUTION

Never leave the old check leaf valve in the bulkhead assembly when fitting the new style inlet elbow and check leaf valve.

3. Observe the differences between the two faces of the baffle. One is slightly recessed, forming a lip. The baffle must be installed so that it is seated inside the recessed area.
4. Insert the check valve leaf tail into the center hole of the baffle. Pull the tail through the baffle until the check valve leaf snaps into place. Before placing the check valve inside the inlet elbow, trim off the excess portion of the tail.
5. Position the check valve inside the inlet elbow with the tail pointing away from the bulkhead (refer to Figure 2-12). Press the part into place firmly, to ensure that it remains snug against the lip inside the inlet elbow.
6. Install the check leaf valve (33440) using the new inlet elbow (35272) onto the bulkhead inlet port.

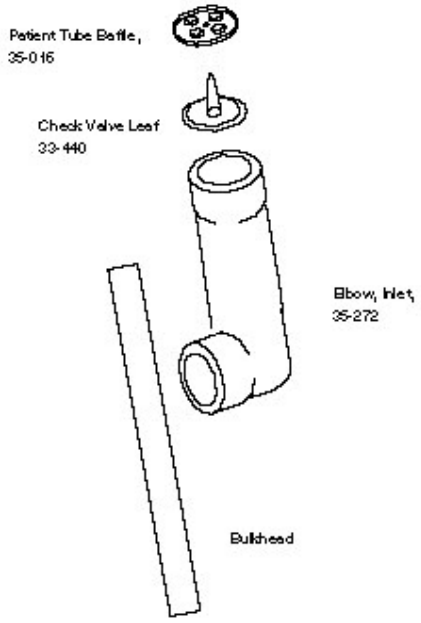


FIGURE 7-12 RELOCATING CHECK LEAF VALVE

7.16 MOTOR LEAD RESISTANCE TEST (OPTIONAL)

This test is used to determine the remaining life of the motor. This test is not all inclusive, and is not to be used to determine whether a motor is fit for use in a ventilator. Instead, this test is used to determine how much wear the motor has experienced when it is combined with the motor's total operating hours, environmental operating conditions, frequency of Preventive Maintenance, etc.

7.16.1 EQUIPMENT REQUIRED

- 12 Volt Adjustable Power Supply
- Vise
- Voltmeter

7.16.2 PROCEDURE

The following test is used to measure motor terminal resistance (rt). This method reduces errors due to varying conditions of the brush film. The brush film always varies from motor to motor depending on the duty cycle, running time, temperature, armature type, and brush grade of the motor.

1. Connect a scrap motor coupler to the motor shaft, and tighten the other end of the motor coupler in a vise. This prevents armature rotation during the test. Hold the motor housing firmly to prevent rotation.

CAUTION

Do not lock the motor shaft directly into a vise. This causes serious damage to the internal motor shaft.

2. Apply DC voltage to the motor. Begin with the DC voltage at less than 0.5 volts and increase the voltage until the amp meter reads 4.0 amps. With 4.0 amps applied to the motor, measure the voltage across the motor leads and record this reading. Do not apply voltage to the motor for more than five seconds to avoid heating the armature, (measurements lasting longer than five seconds affect measurement repeatability).
3. Determine terminal resistance by using the following equation:

$$\textit{Terminal Resistance (rt)} = \frac{\textit{Measured Voltage}}{\textit{4.0 Amps}}$$

4. Rotate the motor shaft 90° and repeat the terminal resistance steps. Perform the test four times at 90° intervals. Average the four terminal resistance values together. The resistance value is specified at 25°C, and the nominal value is 0.365 ohms.

NOTE

The method of checking resistance across the leads with an ohmmeter does not give consistent or repeatable results, because it does not take into account the variations in the brush film. Current is required to "break" through the brush film.

5. Evaluate motors with significantly higher than average terminal resistance values to determine whether the motor is fit for service or requires replacing with a new motor.

7.17 MOUNTING PLV-100 OPTICAL SWITCH ASSEMBLY

There are two types of optical switch mounting brackets. The old style mounting bracket, (35357), is a machined block of aluminum (see Figure 2-13). The new style mounting bracket, (35601), is stamped plated steel (see Figure 2-14). Replacement kit F35844 contains the new style mounting bracket.

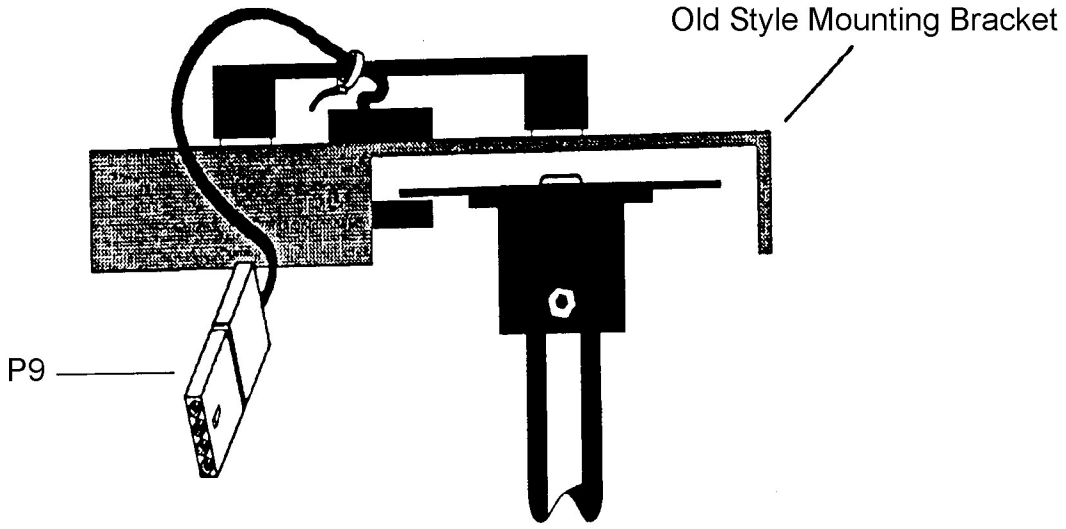


FIGURE 7-13 OLD STYLE OPTO-SWITCH MOUNTING BRACKET

The optical switches contained in these two styles of mounting brackets are not interchangeable. Do not attempt to place a new style optical switch into an old style mounting bracket.

7.17.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- 99-20 Allen Wrench
- Wire Cutters

7.17.2 PROCEDURE

1. Remove the old-style optical switch assembly by disconnecting the opt-switch assembly from the unit wiring harness at the 4-pin Molex connector, P9. Remove the two 4-40 screws that secure the mounting bracket to the motor housing, and discard the screws. Carefully slide the old mounting bracket away from the encoder wheel (35014).
2. The encoder wheel is very delicate. Replace the encoder wheel if it is damaged in any way to ensure proper ventilator operation.
3. Remove the opto-switch assembly from the motor, and install the new-style optical switch assembly.
4. Position the new optical switch assembly onto the motor housing. The 128-segment encoder wheel fits between the optical switch transmitter and receiver. Use the two 4-40 x ¼ inch screws, included in the kit, to secure the optical switch assembly to the motor housing.
5. Using a 99-20 Allen driver loosen the encoder wheel set screw. Position the wheel as close to the optical switch receiver as possible, (see Figure 2-14). Apply a small amount of Loctite 222, (98016), to the set screw then tighten against the flat section of the motor shaft.

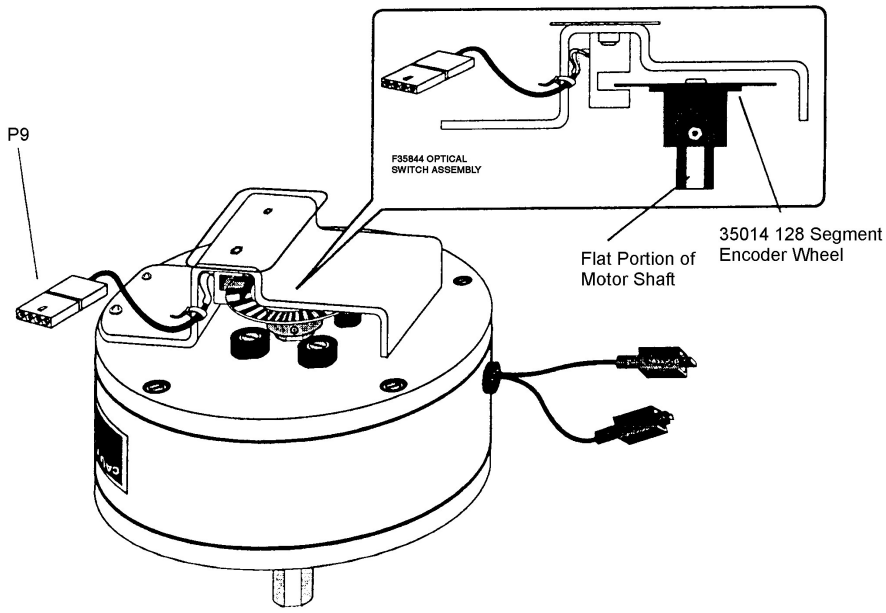


FIGURE 7-14 NEW STYLE OPTO-SWITCH MOUNTING BRACKET

6. Slowly rotate the ball screw while watching the encoder wheel. The encoder wheel must not contact the optical switch at any point in the rotation. The distance between the encoder wheel and the optical switch receiver must remain constant throughout the entire rotation. If this distance varies, loosen the set screw and reposition the wheel. If the distance between the encoder wheel and receiver still varies replace the wheel.
7. Remove resistor R21 from between the 50-pin ribbon cable connector and the 14-pin ribbon cable connector near the bottom of the digital board. The 4.02 K ohm resistor must be cut out of the circuit for the new optical switch to function properly. Cut the leads of R21 as close to the circuit board as practical. Discard the resistor.

7.18 SILENT BLOCK/BALL SCREW ASSEMBLY

7.18.1 EQUIPMENT REQUIRED

- Phillips Screwdriver

7.18.2 PROCEDURE

1. Remove the motor from the bulkhead according to the appropriate procedures. Do not attempt to disassemble the ball screw or remove the ball screw from the silent block/ball screw assembly. The silent block assembly can be removed from the piston without removing the piston from the cylinder.
2. Remove the six screws from the ring clamp and remove the silent block/ball screw from the piston assembly.

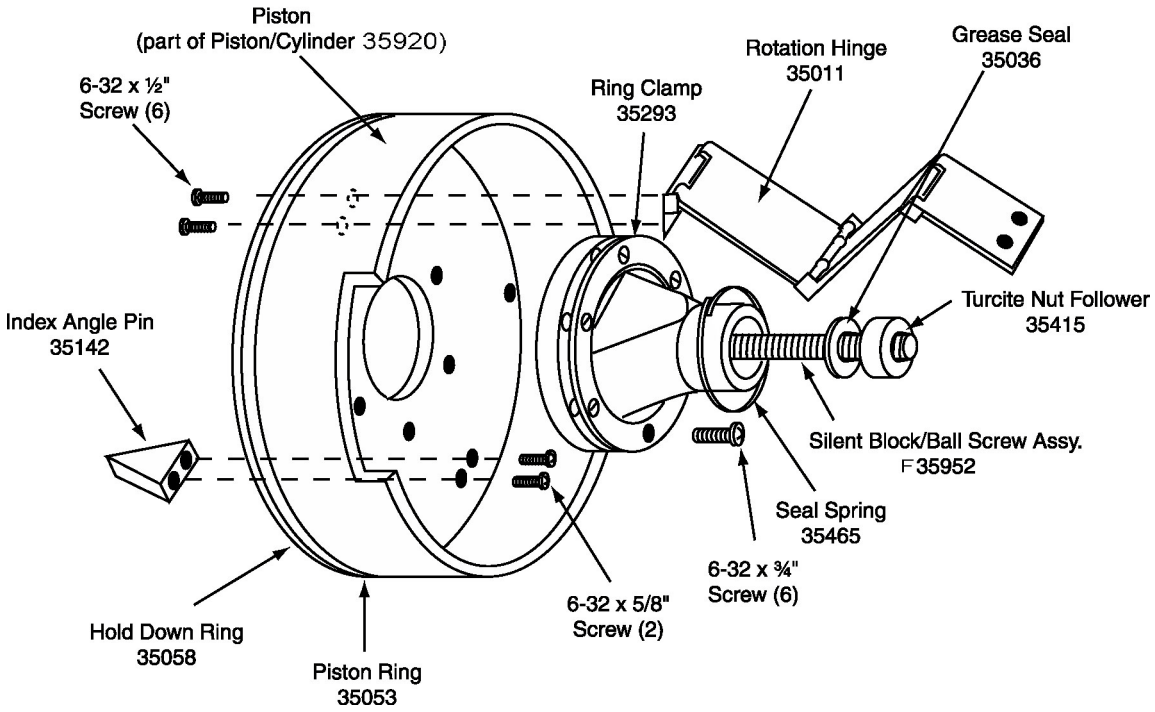


FIGURE 7-15 PISTON AND SILENT BLOCK/BALL SCREW ASSEMBLY

3. Inspect the ball screw for looseness and erratic movement. If replacement is required, replace the entire ball screw and silent block assembly.
4. To reassemble the silent block/ball screw assembly, loosely attach the silent block to the piston ensuring that the flat part of the silent block is seated parallel to the rotation hinge.
5. Loosely put the six mounting screws in place. Slide the piston forward until it contacts the bulkhead. Install the motor assembly according to the proper instructions. When installing the silent block, loosely cross-tighten the 6-32 x ¾ inch screws until snug, then tighten to ensure proper alignment of the piston.
6. Turn the ball screw until the piston contacts the push-button switch. Back the piston off slightly. An audible click sounds as the switch is disengaged.
7. Reassemble the unit enough to allow for piston/cylinder operation. Turn on the unit for a few cycles. Check that the end of the ball screw does not have a “figure 8" or “wagging” motion (oscillation). If motion is detected, stop the unit on an out stroke and loosen the silent block. Repeat the silent block installation procedures until proper alignment is achieved.

7.19 BALL SCREW ASSEMBLY INSPECTION

Inspect the ball screw for any looseness, roughness, or erratic movement. Replace the entire ball screw and silent block assembly together. Lubrication of the ball screw assembly is done during each service inspection. Refer to Section 2.21 Ball Screw Lubrication for complete instructions on lubricating the ball screw assembly.

7.20 BULKHEAD, CYLINDER, AND PISTON SERVICE

7.20.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- 5/16” Nut Driver
- Torque Wrench

7.20.2 PROCEDURE

1. Remove the motor assembly as previously described. Disconnect the coupler from the ball screw only. The coupler must remain attached to the motor. If it is necessary to remove the coupler from the motor, the motor's mounting plate must first be removed.
2. Disconnect the hinge from the hinge mount by removing the two 6-32 screws. Remove the hinge mount from the cylinder by removing the two 6-32 KEP nuts. Remove the hinge mount spacers from the studs in the cylinder.

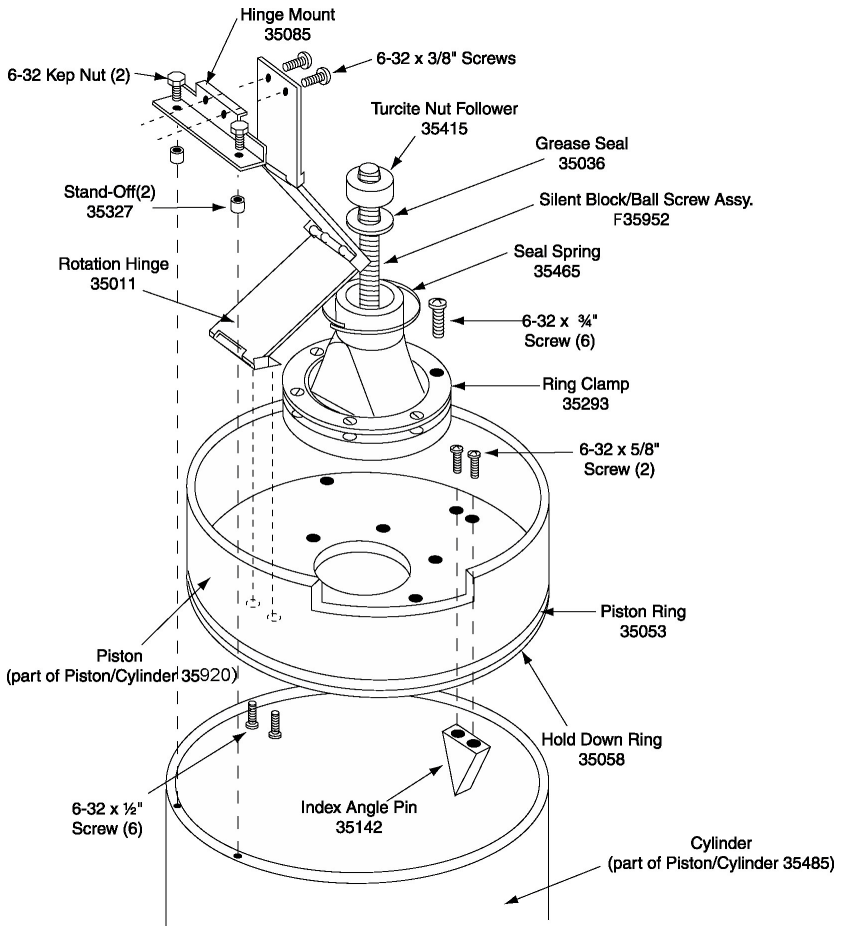


FIGURE 7-16 HINGE MOUNT ASSEMBLY

3. Remove the six nuts which secure the bulkhead assembly to the cylinder. Remove the bulkhead assembly. Slide the piston assembly out through the rear of the cylinder. This prevents damage to the piston ring.

4. Do not sand or polish the piston or cylinder. Clean the piston/cylinder with a mild detergent or alcohol only. Dry thoroughly before reassembly of the piston/cylinder.
5. Replace the piston ring if it shows signs of uneven wear or when piston movement is noisy.
6. Remove the rotation hinge from the rear of the piston. Remove the two 6-32 x 5/8 inch screws that secure the index pin to the front of the piston. Remove the four screws that secure the hold down ring in place. Discard the piston ring.
7. Align a new piston ring, (35053), with the screw holes on the piston. Place the hold down ring with bent edge against the piston ring. Insert the four screws that secure the hold down ring in place from the head side of the piston. Loosely attach the four lock nuts on the screws from the rear of the piston. Install both the rotation hinge and index pin to the piston according to Figure 2-15.
8. If the piston/cylinder is still noisy after the piston ring is replaced, replace the piston/cylinder (35920).
9. Insert the piston assembly into the cylinder from the bulkhead side. Check that the piston ring folds up and is in contact with the cylinder all the way around the piston and no gaps are present. Move the piston back and forth a few times to align the piston ring. Tighten the four screws that secure the hold down ring in place.
10. Reinstall the hinge mount standoffs to the cylinder and connect the rotation hinge to the hinge mount.
11. Align the gasket with the six bulkhead studs on the cylinder. Ensure that the gasket lies flat and is not catching on the threads of the cylinder. Replace the gasket if damaged. Do not use adhesive on this gasket.

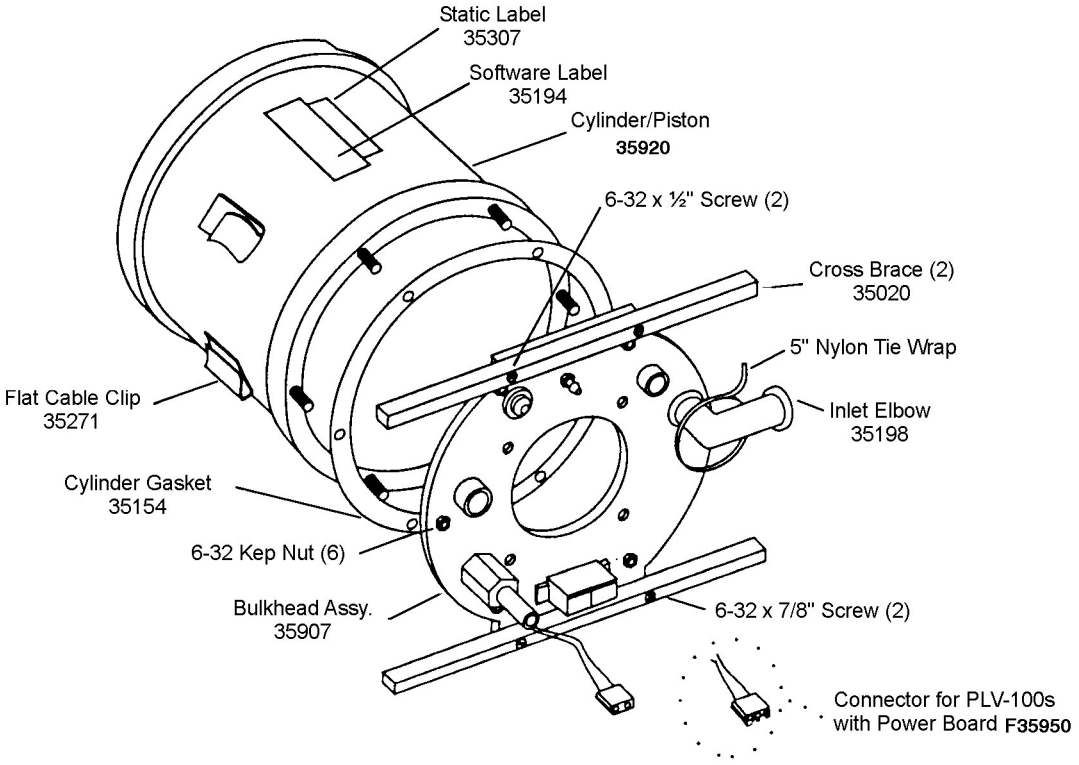


FIGURE 7-17 BULKHEAD PISTON/CYLINDER ASSEMBLY

12. Mate the bulkhead to the cylinder and check that the gasket has no folds in it. Tighten the bulkhead to the cylinder as follows:
    a. Tighten screws 1 through 6 according to Figure 2-18, (in numerical order), to 10 inch pounds.
    b. Tighten screws 1 through 6 in order to 15-inch pounds.
    c. Tighten screws 1 through 6 to 20-inch pounds. This technique is used to create equal pressure against the gasket.

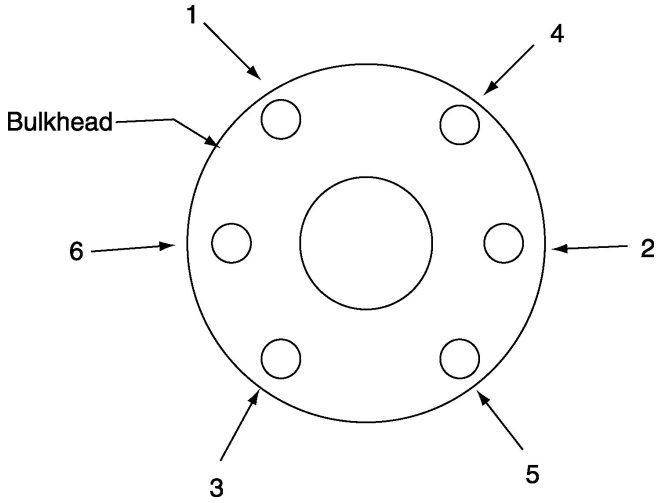


FIGURE 7-18 BULKHEAD TIGHTENING SEQUENCE

7.21 BALL SCREW LUBRICATION

7.21.1 EQUIPMENT REQUIRED

- Syringe
- Kimwipe Towel

7.21.2 PROCEDURE

Lubricate the ball screw assembly during each preventive maintenance. The following parts are required to change the lubrication in the ball screw from Mobile #28 to Krytox:

Qty.	*Part*	*Description*
1	*35465*	*Spring, Seal*
A/R	*1061272 / 1061271* *or* *1061274 / 1061273*	*Grease, Krytox 240* *or* *Grease, Krytox FG20*
1	*35036*	*Grease Seal*

NOTE

The new Krytox (1061274 and 1061273) can be used with the new Armoloy Ball Screw (see Figure 2-19) and the old Carbon Steel Ball Screw but first you must remove as much of the original Krytox (1061272 or 1061271) as possible from the old Carbon Steel Ball Screw. The original Krytox (1061272 or 1061271) should not be used with the new Armoloy Ball Screw.

FIGURE 7-19 NEW ARMOLOY BALL SCREW

WARNING

Avoid grease contact with eyes and skin. Wash hands thoroughly after handling grease. Do not consume food, drink, or use tobacco that has become contaminated with the grease. Use gloves when handling the ball screw.

It is not necessary to remove the ball screw from the piston or the silent block for the following procedure.

1. Lower the left module from the unit according to the steps previously described in Section 2.1. Fold the left module onto the work surface being careful not to stress the electrical wiring.
2. Remove the seal spring from the silent block by firmly pulling the spring seal away from the piston/cylinder. Discard the seal spring. Unscrew the follower nut and remove it from the ball screw.

NOTE

Old style "screw on" turcite nuts sometimes caused squealing. New style turcite nuts are not threaded and push on into location.

3. Wipe the grease off the ball screw and follower nut using a Kimwipe towel (see Figure 2-15).
4. Place a new seal spring, (35465) all the way over the far end of the silent block. Inject approximately 2.5 cc of Krytox into the silent block grease chamber. Screw the follower nut on the ball screw until half of the nut is inside the silent block grease chamber. Pull the seal spring over the follower nut. Screw the rest of the follower nut into the silent block. Wipe off the excess grease that extrudes through the follower nut using a Kimwipe towel.

5. Operate the unit, with the left panel still removed, at a slow speed, (set the flow rate and BPM rate low, and set the volume high). Lubricate the ball screw with a small amount of grease using a Kim-wipe towel.

7.22 35903 Power Board Retrofit

The old style 35903 power board may be replaced with the newer style 35950 power board. There are three levels of replacement for these boards.

7.22.1 Level 1

Level 1 upgrades the PLV-100 35903 power board to the F35950 power board while maintaining the original mechanical vent and AMP board. Perform the following procedures to retrofit the power board to a Level 1 upgrade.

7.22.1.1 Equipment Required

- Power Board (F35950)
- (2) Berg Jumpers (35312)

7.22.1.2 Procedure

1. Lower the right module of the unit, and remove the old 35903 power board according to the instructions in this Chapter.
2. Install the new F35950 power board on the right module. Make sure there is no Berg jumper (35312) on J1 and J4 of the new power board. Plug the 50-pin ribbon cable to the digital board, and plug in the remote alarm connector to P8 on the power board. Plug the Alarm silence switch/ LED connector to P1, and the 14-pin ribbon cable to P9 on the power board.
3. Adjust the board voltages to the specifications listed in Table 5-1 of this manual. Perform Operational Checks, and Calibration and Testing to verify proper unit operation.

7.22.2 Level 2

Level 2 upgrades the PLV-100 35903 power board to the F35950 power board while maintaining the mechanical vent. The AMP board is disposed of as the unit uses the pressure transducer on the new power board. Perform the following procedures to retrofit the power board to a Level 2 upgrade.

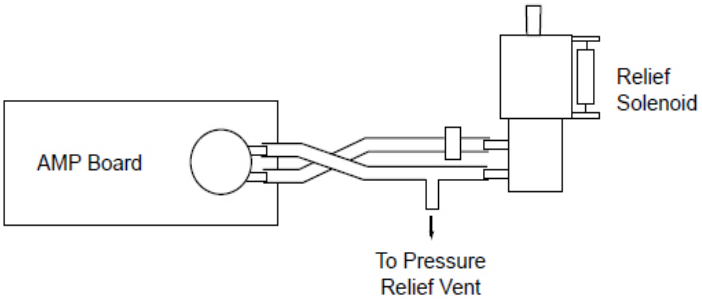
7.22.2.1 Equipment Required

- Power Board (F35950)
- (2) Berg Jumpers (35312)
- 14 Conductor Ribbon Cable (35997)
- 12" Red Wire (38035)
- 12" Black Wire (38041)
- (2) Contacts (37075)
- Conn/E Female 2-Pin (39572)
- (2) Tubing, PVC 3/32” x 2.5" (35202)
- (2) Tubing, PVC 1/8” x 6.5" (C06685)
- Reducer 3/32” to 1/8” (35203)
- Tee, 1/8” (33790)

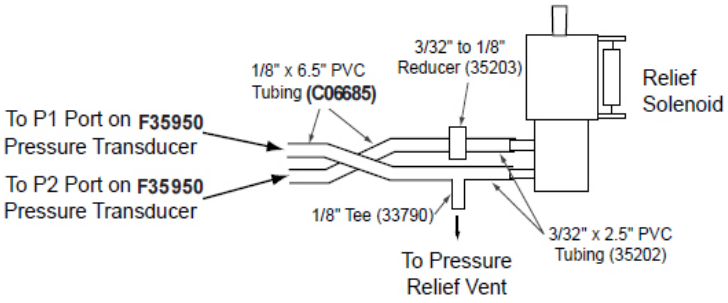
- (6) 4" Cable Ties

7.22.2.2 PROCEDURE

1. Lower the right module of the unit, and remove the old 35903 power board according to the instructions in this Chapter.
2. Disconnect the pressure transducer tubing and ribbon cable from the AMP board. Remove the AMP board, and the mechanical vent assembly according to the instructions located in this Chapter.
3. Disconnect the ribbon cable from the hour meter and the digital board. Install the new 2-pin connection cable by soldering the wires onto the hour meter circuit board. The red wire is soldered to the +5V connection in the center of the circuit board and the black wire is soldered to the Ground connection below the 5 volt connection.
4. Install the new F35950 power board on the right module. Place a Berg jumper (35312) on J1 and J4 of the new power board. Plug the 50-pin ribbon cable to the digital board. Using the tubing, connect the zero reference solenoid to the pressure transducer according to Figure 2-20.



35903 Power Board


1/8" x 6.5" PVC Tubing (C06685)
3/32" to 1/8" Reducer (35203)
Relief Solenoid
To P1 Port on F35950 Pressure Transducer
To P2 Port on F35950 Pressure Transducer
1/8" Tee (33790)
3/32" x 2.5" PVC Tubing (35202)
To Pressure Relief Vent

F35950 Power Board

FIGURE 7-20 PNEUMATIC CHANGE FOR POWER BOARD RETROFIT

5. Plug the hour meter cable to P7 of the new power board. Using the 14-pin ribbon cable (35997) supplied in the kit, connect P3 on the digital board to P5 on the power board. Plug the remote alarm connector to P8 on the power board. Plug the Alarm Silence switch/LED connector to P1, and the 14-pin multicolored ribbon cable to P9 on the power board.
6. Adjust the board voltages to the specifications listed in Table 5-1 of this manual. Perform Operational Checks, and Calibration and Testing to verify proper unit operation.

7.22.3 LEVEL 3

Level 3 upgrades the PLV-100 35903 power board to the F35950 power board while adding the electronic dump. The AMP board is disposed of as the unit uses the pressure transducer on the new power board. Perform the following procedures to retrofit the power board to a Level 3 upgrade.

7.22.3.1 EQUIPMENT REQUIRED

- Power Board (F35950)
- 14 Conductor Ribbon Cable (35997)
- 12" Red Wire (38035)
- 12" Black Wire (38041)
- (2) Contacts (37075)
- Conn/E Female 2-Pin (39572)
- (2) Tubing, PVC 3/32” x 2.5" (35202)
- (2) Tubing, PVC 1/8” x 6.5" (C06685)
- Reducer 3/32” to 1/8” (35203)
- Tee, 1/8” (33790)
- (6) 4" Cable Ties

7.22.3.2 PROCEDURE

1. Lower the right module of the unit, and remove the old 35903 power board according to the instructions in this Chapter.
2. Disconnect the pressure transducer tubing and ribbon cable from the AMP board. Remove the AMP board, and the mechanical vent assembly according to the instructions located in this Chapter.
3. Install the electronic dump bushing (35179) to the front panel. Place the electronic dump pot assembly (35958) through the front panel.
4. Replace the current dump valve with the electronic dump valve (F35830).
5. Disconnect the ribbon cable from the hour meter and the digital board. Install the new 2-pin connection cable by soldering the wires onto the hour meter circuit board. The red wire is soldered to the +5V connection in the center of the circuit board and the black wire is soldered to the Ground connection below the 5 volt connection. Crimp a contact (37075) to the end of each wire. Insert the red wire into the Pin 2 socket and the black wire into the Pin 1 socket of the female connector (39572).
6. Install the new 35950 power board on the right module. Make sure no berg jumper is on J1 and J4 of the new power board. Plug the 50-pin ribbon cable to the digital board. Using the tubing, connect the zero reference solenoid to pressure transducer according to Figure 2-20.
7. Plug the hour meter cable to P7 of the new power board. Using the 14-pin ribbon cable (35997), connect P3 on the digital board to P5 on the power board. Plug the remote alarm connector to P8

on the power board. Plug the Alarm Silence switch/LED connector to P1, and the 14-pin multicolored ribbon cable to P9 on the power board. Plug the dump pot to P2, and the dump valve to P6 on the power board.

Adjust the board voltages to the specifications listed in Table 5-1 of this manual. When performing a level 1 power board retrofit, while maintaining the mechanical vent and AMP board, you will not need to adjust TP11 and TP12 like Table 5-1 states. When performing a level 2 power board retrofit, while maintaining the mechanical vent and AMP board is disposed of so the unit uses the pressure transducer on the new power board, you will need to adjust TP11 but not TP12. When performing a level 3 power board retrofit, the mechanical vent is replaced with the electronic dump, and the AMP board is disposed of so the unit uses the pressure transducer on the new power board, you will need to adjust both TP11 and TP12. Perform Operational Checks, and Calibration and Testing to verify proper unit operation.

7.23 UNIT FINAL ASSEMBLY

1. Before reassembling the PLV-100 unit, check that all applicable ECOs have been installed into the unit. Reassemble the unit according to the instruction located in the previous sections of this chapter.
2. After reassembling the ventilator, turn on the PLV-100. The ventilator performs its automatic internal diagnostic check which checks the front panel digital displays, LEDs, the audible alarm and pressure transducer for proper operation. This 5-second sequence of checks occurs immediately after the unit is turned on.

CHAPTER 8 MANDATORY ENGINEERING CHANGE ORDERS

Each PLV-100 must have the following engineering change orders installed. The changes listed below are all mandatory changes. Those ECO's which are considered optional are installed upon customer request, and are found in Chapter 2.

If this unit does not have all of these changes installed, install them at the time of service. Record all installed ECO's on the proper documentation.

ECO#	DESCRIPTION
1156	*Encoder Change*
2073	*Hour Meter Installation*
2730	*Watchdog Timer Resistor Change to 127K ohm*
2876	*Multiplexer U19 Change (National chips only)*
2992	*Krytox Lubrication Change*
3288	*Reset Pulse Circuit C7 Capacitor Change*
3814	*Power Board F35950 C26 Capacitor Change*
3909	*Digital Board Counter/Timer Change*
FC2001-46	*Alarm Assembly Upgrade*
FC2006-02	*Inspection of Alarm Module F1000711*
FC2002-06	*PLV-100 Logic Board 35916*
FC2005-06	*PLV, RFI Assembly Mounting Stud Protection*

8.0 ECO #: 1156 ENCODER CHANGE

8.0.1 EQUIPMENT REQUIRED

- Soldering Equipment
- Allen Wrench
- Pliers
- 5/16” Nut Driver
- 24 Gauge Buss Wire (38051)
- 4.02kΩ, 1/8 W, 1% Res (39155)
- 200 kΩ, ¼ W, 5% Res (39499)
- 20 kΩ, ¼ W, 5% Res (39017)
- Optical Switch Assembly (35844F)
- EPROM

8.0.2 PROCEDURE

1. Remove the knobs and O-rings from the faceplate module. Remove the nuts that secure the potentiometers to the faceplate module. Unscrew the nut from the 30-second alarm silence button, if installed.

WARNING

Observe all antistatic precautions before handling printed circuit boards. Refer to Antistatic Control Procedures for information concerning the handling of static sensitive parts. All persons handling static sensitive parts must be grounded via a 1 Meg Ohm resistive grounded wrist strap.

2. Lower the faceplate module according to the proper steps in Chapter 7. Disconnect the blue ribbon cable (P3) from the top of the digital board.
3. Disconnect the ¼-inch OD clear tube from the exhalation valve fitting to the bulkhead cylinder by pulling it away from the bulkhead cylinder fitting. Disconnect the ¼-inch OD clear tube from the zero reference solenoid, (on the back module), to the assist/pap fitting and front panel pressure gauge at the tee.
4. Move the faceplate module to the right to allow the patient elbow to disengage from the patient outlet. Lower the faceplate module to the work surface. Use care not to stress the electrical wiring or components.
5. Remove the three 6-32 nylon nuts that secure the digital board to the rear of the faceplate module. Disconnect cables P1 and P2, and carefully remove the digital board from the faceplate module. Desolder the three wires that connect the battery switch at the switch end, and the four wires that connect the ON/OFF switch to the digital board at the switch end.
6. To modify the digital board for the 128-segment encoder, desolder C21 and discard. Fill the component space with solder. Remove and discard R20, and solder a 24 gauge buss wire (38051) across the R20 mounting holes. Replace R21 with a 4.02 kΩ, 1/8-W, 1% resistor, (39155). Replace R22 with a 200 kΩ, ¼-W, 5% resistor, (39499). Replace R23 with a 20 kΩ, ¼-W, 5% resistor, (39017).
7. Install the most current EPROM revision into the unit.
8. Remove the 18-segment encoder and discard. Place the new 128-segment encoder on the motor shaft. Set the new optical switch assembly (F35844) onto the motor housing. Using the two 4-40 x ¼-inch screws provided with the kit, secure the optical switch assembly to the motor housing. Move the opto-wheel as close to the transistor as possible without contacting the transistor (see Figure 7-14).
9. Reassemble the faceplate module. Replace units with a faceplate for 30 BPM with the current 40 BPM faceplate revision, (35216).
10. Screw one pot nut on the volume pot, and place one gasket next to the pot nut. Place one gasket on each of the remaining pots and switches. Solder the power switch wires and battery switch wires to the digital board (see Figure 2-1).

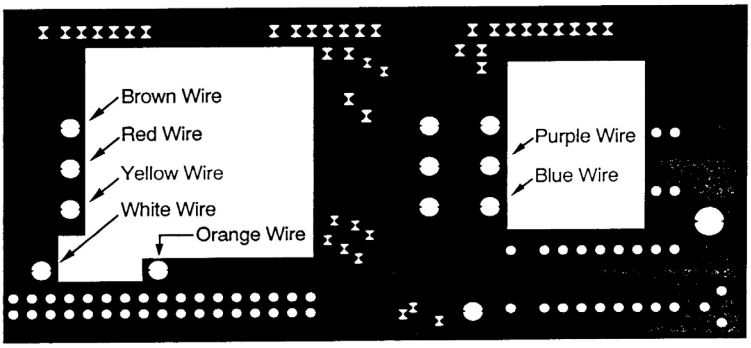


FIGURE 8-1 POWER SWITCH AND BATTERY SWITCH WIRE LOCATIONS

11. Secure the digital board to the faceplate using three 6-32 nylon nuts. Secure the pots to the faceplate with the pot nuts. Place the O-rings onto the pot stems followed by the knobs. Tighten the set screws to secure the knobs in place.

8.1 ECO #: 2073 HOUR METER INSTALLATION

Kit 35996, PLV-100 Hour Meter Retrofit Kit, is required to perform this ECO change.

8.1.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Soldering Equipment
- Kit, Retrofit, PLV-100 Hour Meter (35996)

8.1.2 PROCEDURE

1. Lower the right, left, faceplate, and back module from the unit according to the steps in Chapter 7. Disconnect the 14-pin ribbon cable from P3 on the top of the logic board. Disconnect the inlet elbow from the back module inlet. Disconnect the top internal battery connection.
2. Fold the back module down onto the work surface taking care not to stress any cables or tubing.
3. Disconnect the tubing from the zero reference solenoid valve where the tubing connects to the PAP tee connector near the front panel.
4. Unsolder the white power meter from the top edge of the power board. Carefully break the bond between the power meter and the power board by exerting pressure downward on the power meter. Remove the power meter from the power board.
5. Remove the top left and right screws from the machine air filter housing on the back panel of the unit. Insert two 4-40 x 3/8-inch screws into the holes of the machine air filter housing, and tighten until snug. Place the 4-40 stand-offs on the two 3/8-inch screws on inside of the back module. Using the two 4-40 x ¼-inch screws removed from the machine air filter housing, secure the hour meter PC board to the stand-offs.

6. Fold the ribbon, according to Figure 2-2, and connect it to the header on the hour meter PC board.

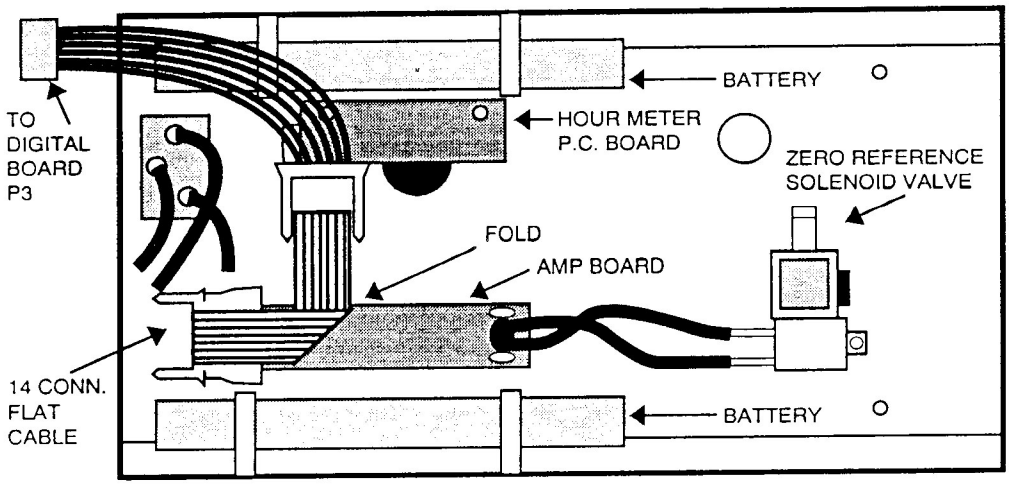


FIGURE 8-2 HOUR METER INSTALLATION

7. Reassemble the unit according to the steps in Chapter 7.

8.2 ECO #: 2730 WATCHDOG TIMER RESISTOR CHANGE

Kit 39323, 127Ω 1/8-W, 1% Resistor, is required to perform this ECO change.

This hardware improvement allows the microprocessor more time to complete its operating tasks. A higher value resistor placed in the watchdog time circuit on the digital and logic boards reduces the possibility of the unit experiencing a reset.

8.2.1 EQUIPMENT REQUIRED

- Soldering Equipment
- Cutters
- Kit, 127Ω, 1/8 W, 1% Res (39323)

8.2.2 PROCEDURE

WARNING

Observe all antistatic precautions before handling printed circuit boards. Refer to Antistatic Control Procedures for information concerning the handling of static sensitive parts. All persons handling static sensitive parts must be grounded via a 1 Meg Ohm resistive grounded wrist strap.

1. Remove resistor R11 located near the top left-hand corner of the digital board. Do not allow the tip of the soldering iron to contact any other components on the circuit board. When soldering the resistor leads applying too much heat causes the circuit pad to separate from the board, resulting in an open trace. Use the proper solder removal tools.

2. Install the new 127 K ohm, 1/8-W, 1% resistor in R11. Clip off the excess leads on the solder side of the circuit board. Clean around the soldered area, as necessary, using M-114 or an equivalent solvent. Inspect all solder joints surrounding the new resistor on both sides of the circuit board for integrity of each solder joint.

8.3 ECO #: 2876 MULTIPLEXER U19 CHANGE (NATIONAL CHIPS ONLY)

If U19 on the digital board is a National Semiconductor Multiplexer, remove and discard it along with the filter capacitor under the multiplexer. Install a new stocked multiplexer (39129) and a new filter capacitor (39372). The new multiplexer is not a National Semiconductor Multiplexer.

8.4 ECO #: 2992 KRYTOX LUBRICATION CHANGE

The purpose of this ECO is to change out the original Mobile #28 grease with the more recent Krytox grease. Units with the original Mobile #28 grease are easily recognized by the red discoloration of the silent block assembly.

8.4.1 EQUIPMENT REQUIRED

- Seal Spring (35465)
- Grease Seal (35036)

8.4.2 PROCEDURE

The following items are required to change the lubrication in the silent block assembly from Mobile #28 to Krytox:

Qty	*Part Number*	*Description*
1	*35036*	*Grease Seal*
1	*35465*	*Seal Spring*
A/R	*1061272 / 1061271* *or* *1061274 / 1061273*	*Krytox 240 Grease* *or* *Krytox FG20 Grease*

NOTE

The new Krytox (1061274 and 1061273) can be used with the new Armoloy Ball Screw (see Figure 7-19) and the old Carbon Steel Ball Screw but first you must remove as much of the original Krytox (1061272 or 1061271) as possible from the old Carbon Steel Ball Screw. The original Krytox (1061272 or 1061271) should not be used with the new Armoloy Ball Screw.

WARNING

Observe the following safety precautions for Krytox grease: Avoid contact with eyes and skin. Wash hands thoroughly after handling. Do not consume food, drink, or use tobacco that has become contaminated with the grease. Use gloves when handling the ball screw.

1. Lower the left module according to the instructions listed in Chapter 7. Fold the left module down onto the work surface being careful not to stress the electrical wiring.
2. Remove the seal spring from the silent block by firmly pulling the spring seal away from the piston/cylinder. Discard the seal spring. Remove the follower nut and remove it from the ball screw. Remove the felt washer and discard.
3. Wipe any Mobile #28 grease off the ball screw and follower nut using a Kimwipe towel. Place the seal spring over the silent block as far as it will go. Align the grease seal with the counter-bore facing away from the ball nut and screw on the ball screw until firmly against the ball nut inside the silent block (see Figure 2-3).

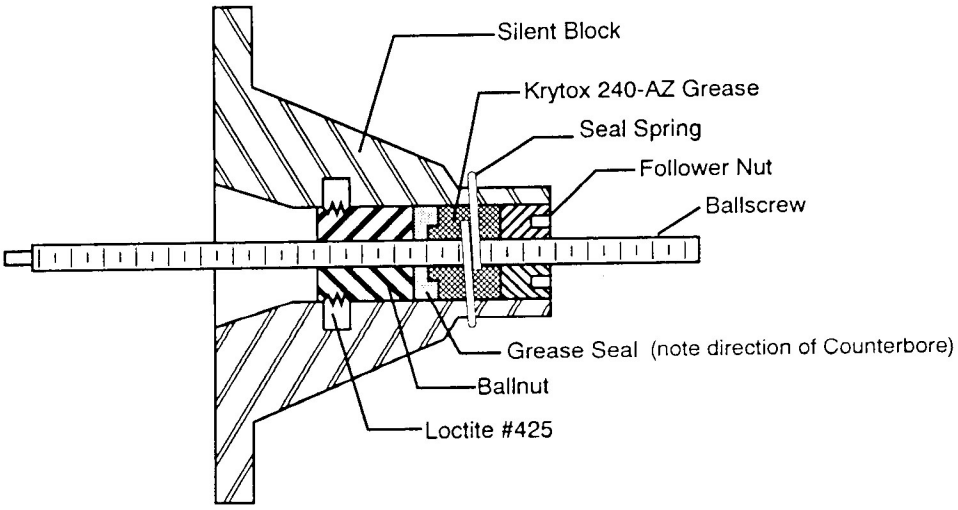


FIGURE 8-3 BALL SCREW ASSEMBLY

4. Inject approximately 2.5 cc of Krytox grease into the silent block grease chamber. Screw the follower nut on the ball screw until half of the nut is inside the silent block grease chamber. Pull the seal spring over the follower nut. Screw the rest of the follower nut into the silent block. Old style “screw on” turcite nuts sometimes caused squealing. New style turcite nuts are not threaded and push on into location. Wipe off any excess grease that extrudes through the follower nut using a Kimwipe towel.
5. Operate the unit, with the left panel still removed, at a slow speed, (set the unit to low flow and BPM rate, and a high volume). Lubricate the ball screw with a small amount of grease using a Kimwipe towel.

8.5 ECO #: 3288 Reset Pulse Circuit C7 Capacitor Change

The replacement of the 2.2 µF reset pulse circuit capacitor with a 22 µF, 35V, 20% tantalum capacitor (39689), allows the audible alarm to sound for a longer duration during a reset pulse trigger. This change is incorporated with every PLV-100 when servicing the unit.

8.5.1 Equipment Required

- Soldering Equipment
- Cutters
- 22uF, 35V 20% Cap (39689)

8.5.2 Procedure

WARNING

Observe all antistatic precautions before handling printed circuit boards. Refer to Antistatic Control Procedures for information concerning the handling of static sensitive parts. All persons handling static sensitive parts must be grounded via a 1 Meg Ohm resistive grounded wrist strap.

1. Locate capacitor C7 near the top left-hand corner of the digital board, (see Figure 2-4). The capacitor designator (C7) is silk-screened onto the printed circuit board adjacent to the integrated circuit chip U24.

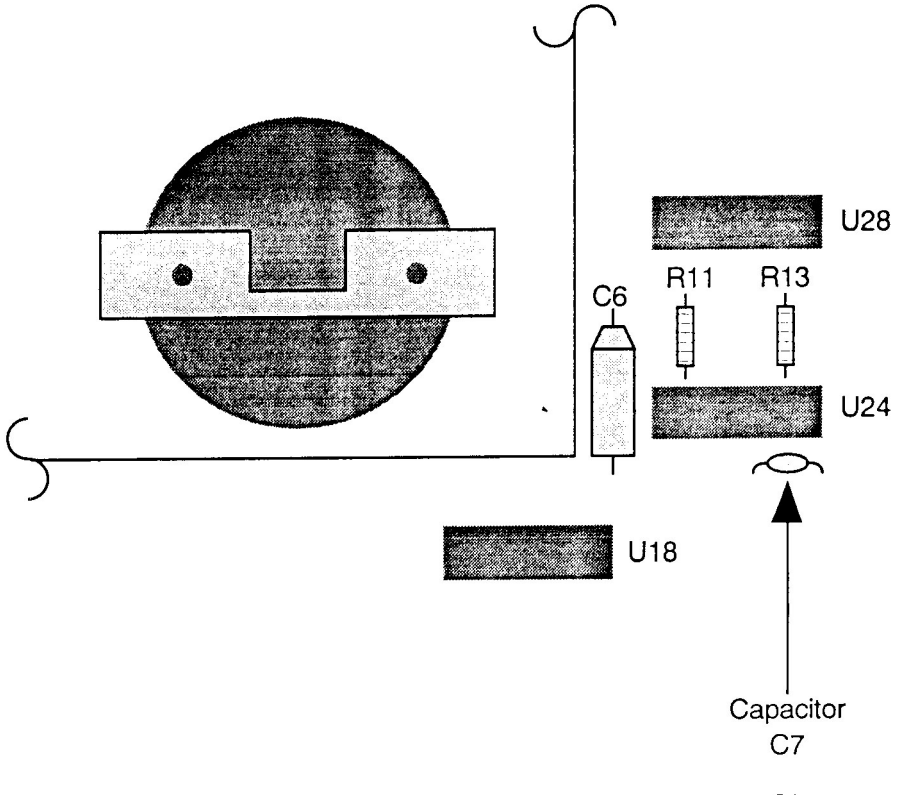


FIGURE 8-4 C7 LOCATION ON THE DIGITAL BOARD

2. Disconnect the 50-pin ribbon cable to remove all power from the digital board before soldering.
3. Observe the polarity of the C7 capacitor installed for future installation of the new capacitor. Carefully desolder the 2.2 µF capacitor from the digital board. Do not allow the tip of the soldering iron touch any other components, especially U24, on the digital board.
4. Install the new 22 µF, 35V, 20% capacitor in C7 on the digital board. Observe the correct polarity. Use caution when soldering the new capacitor in place to avoid using too much heat.

8.6 ECO #: 3814 POWER BOARD F35950 C26 CAPACITOR CHANGE

This ECO directs the removal and replacement of capacitor C26 on all PLV-100s that have a F35950 power board installed. These power boards are identified by twelve test points along the top edge of the board. These power boards have been installed into PLV-100s since March 1990.

This ECO replaces C26, a 0.1 µF capacitor with a 10 uF capacitor. The purpose of this capacitor change is to prevent the 30-second alarm silence button LED from lighting when a circuit breaker on the front panel trips.

The earlier version power boards (35903) are not affected by this change. These power boards are identified by the eight test points along the top edge of the board.

8.6.1 EQUIPMENT REQUIRED

- Phillips Screwdriver
- Soldering Equipment

- Voltmeter
- 22uF, 35V 20% Cap (39689)

8.6.2 PROCEDURE

WARNING

Observe all antistatic precautions before handling printed circuit boards. Refer to Antistatic Control Procedures for information concerning the handling of static sensitive parts. All persons handling static sensitive parts must be grounded via a 1 Meg ohm resistive grounded wrist strap.

1. Lower the faceplate and the right modules according to the instructions described in Chapter 7. Disconnect the following connectors from the power board:
   - P1-Alarm Silence Harness
   - P2-Electronic Dump Harness
   - P4-DC Harness
   - P5-Digital Board 14-pin Ribbon Cable
   - P6-Dump Valve Solenoid
   - P7-Hour Meter Harness
   - P8-Rear Panel BNC Connector
   - Disconnect Tubing
2. Lower the right module to the work surface using care not to stress any electrical wiring or tubing. Remove the ground straps that connect the right module to the front and back panels. Remove the four 8-32 x 3/8-inch cross recess screws that secure the power board to the right module (see Figure 2-5).

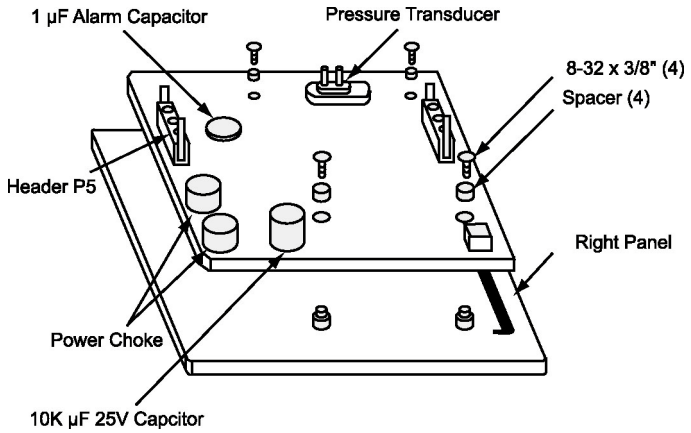


FIGURE 8-5 POWER BOARD F35950

3. Lift the four stand-offs from the screw holes. Carefully remove the power board, with the metal heat sink from the right module. Turn the power board face down on the work area. Remove the

screws securing the three transistors to the heat sink. Remove all three transistors making note of their positions. Remove the heat sink from the power board by lifting straight up.

4. Turn the power board over. The black transducer now faces up and the twelve test points are facing down. The capacitor designator (C26) is printed on the power board to the left of the large round blue alarm capacitor (C23). Capacitor C26 is mounted on the solder side of the power board.

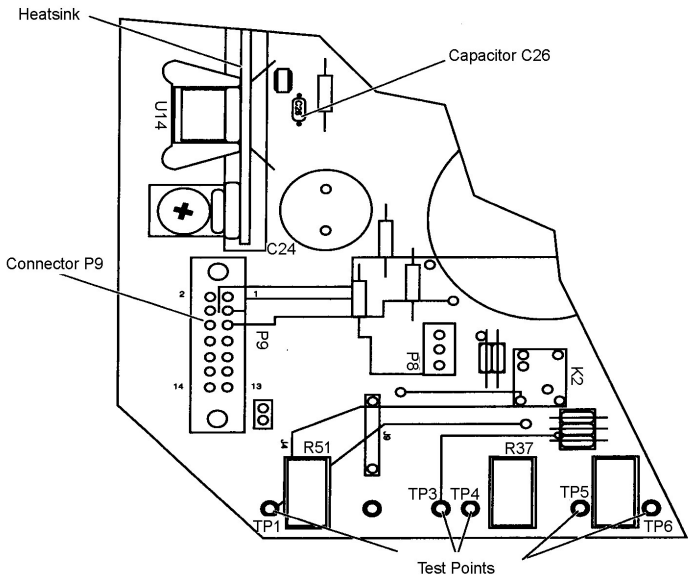


FIGURE 8-6 LOCATION OF C26 ON THE POWER BOARD

5. Using a soldering iron set at a temperature between 700°F and 800°F, carefully remove C26 from the power board. Do not allow the soldering iron to come into contact with any of the other components on the circuit board. Inspect the area around the remove capacitor. Check for damage to the board, or any other components soldered to the board. Clear around the soldered area as necessary using 100% Alcohol or equivalent.
6. The positive side of C26 is the side that is farthest away from the test points. The negative side of C26 is the side that is closest to the test points. If in doubt, the polarity is determined by placing one probe of a multimeter on TP2 of the power board and the other probe on the C26 pad that is closest to TP2. If the multimeter reads continuity the pad is the negative side of C26.
7. Determine the polarity of the new capacitor. The positive side of the new capacitor is identified by a “+” sign closest to the positive lead or the longest lead, (see Figure 2-7). Insert the positive lead of the capacitor into the C26 hole farthest away from TP2. Solder the capacitor into place.

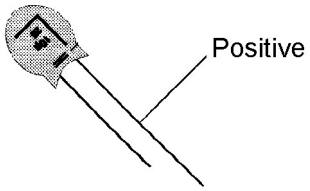
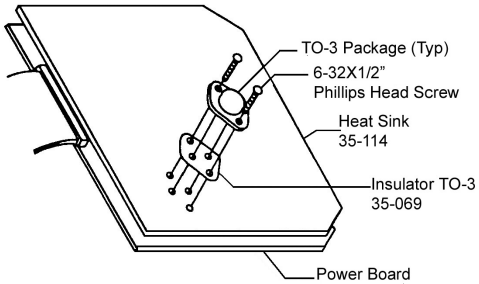


FIGURE 8-7 IDENTIFYING THE POSITIVE SIDE OF C26

8. After soldering the capacitor in place, clip the excess leads from the component side of the board. Clean around the soldered area as necessary using M-114, or an equivalent solvent. Inspect all solder joints surrounding the changed capacitor for integrity.
9. Place the heat sink and the TO-3 components on the power board. Check that the TO-3 components have an insulation transistor pad between the transistor and the heat sink as shown in Figure 2-8.



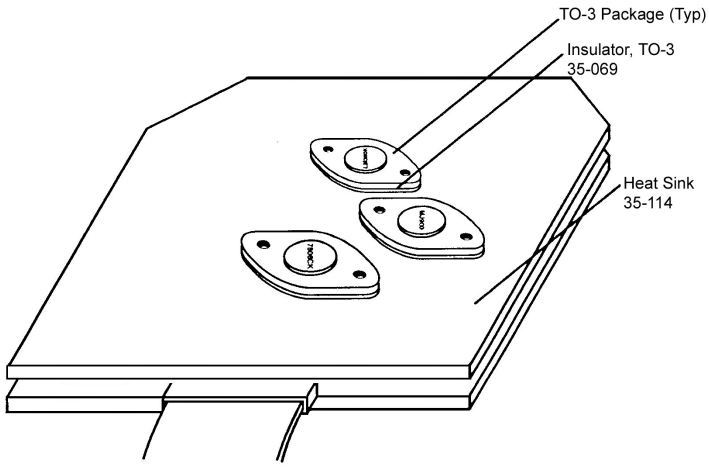


FIGURE 8-8 TO-3 INSTALLATION

8.7 ECO #: 3909 Digital Board Counter/Timer Change

8.7.1 Equipment Required

- 5/16” Nut Driver
- Pliers
- Cutters
- Soldering Equipment
- 0.03 uF Cap (39372)
- Counter/Timer IC (39127)

8.7.2 Procedure

1. Lower the faceplate and right module according to the instructions described in Chapter 7. Remove the digital board from the faceplate module by unscrewing the nut from the 30-second alarm silence button, (if installed), and remove the potentiometer knobs by loosening the set screws. Remove the O-rings and hex nuts securing the potentiometers to the front panel. Place the faceplate down on the work surface. Disconnect all cables from the digital board. Remove the three 6-32 nylon nuts securing the digital board to the faceplate stand-offs and carefully remove the digital board.
2. Locate U28 on the digital board just to the left of the front panel manometer gauge. The component identifier is printed just above and to the left of the chip. Remove U28 from the digital board by cutting each lead of the component. Cut the lead as close to the component as possible.
3. A flat 0.03 µF capacitor is installed under U28. Remove and discard the capacitor during this process. A new 0.03 µF capacitor is installed under the new U28 Chip.
4. Remove the solder from each through hole, and remove the lead of the component with a pair of small needle nose pliers. Visually inspect all conductive patterns such as lands and through holes for damage during the solder removal process. Clean around the soldered area as necessary using M-114, or an equivalent solvent.
5. Insert the new 0.03 µF flat capacitor (39372) into U28. Check that the notch in the capacitor corresponds with the notch in the outline of the chip on the digital board. Solder the new chip into place from the solder side of the digital board. Clean around the soldered area as necessary using M-114 or an equivalent solvent. Inspect all solder joints surrounding the new components for integrity.
6. Insert the new counter/timer IC chip (39127) in the digital board U28. Check that the notch in the IC chip corresponds to the notch on the silk screened digital board. Solder the IC chip in place alternating leads to prevent heat buildup. Clean the soldered area using M-114 or an equivalent solvent.
7. Reinstall the digital board to the faceplate module. Secure the digital board in place using the three nylon nuts. Connect the hex nuts, O-rings, and knobs onto the faceplate potentiometers. Connect the nut to secure the 30-second alarm silence button to the front panel. Connect all wires and cables to the digital board.

8.8 FC2001-46: Alarm Assembly Upgrade

This is a mandatory upgrade to be made on any PLV-100 manufactured before the year 2000 that is serviced or maintained for any reason, including both rental units and customer owned. All units with the old style alarm block assembly (35895), the old style alarm PCB assembly (35896), and units with a serial number beginning with 99 or less must be upgraded to the new style alarm PCB assembly F1000711. The serial number is located on a silver label on the back panel of all PLV units. The purpose of the upgrade is to assure that all PLV

alarms have the latest configuration. In addition, for some older units, other components must be changed for compatibility with the alarm module.

8.8.1 PROCEDURE FOR UNITS WITH POWER BOARD 35950 AND NEW STYLE ZERO BOARD

8.8.1.1 EQUIPMENT REQUIRED

- F1000711-Kit, PLV Alarm Replacement
- 35959-Harness Assembly, Solenoid, PLV-100

8.8.1.2 PROCEDURE

1. Lower the right and front modules according to the instructions in Chapter 7 of this manual.
2. Remove and discard the two screws that secure the old style alarm to the unit whether it is the alarm block, or alarm PCB. If there is a gasket located between the alarm and the front panel, discard it.
3. Remove and discard the two stand-offs from the front panel that the alarm was secured to.
4. Screw the new stand-offs (35042) from the alarm replacement kit onto the front panel PEM studs.
5. Place the new Alarm Assembly onto the stand-offs. See Figure 2-9 for alarm placement.
6. Secure the alarm assembly to the stand-offs with the two washers and screws provided in the replacement kit.
7. The alarm is a critical component. Document the alarm change and lot code of the alarm.
8. Connect the harness assembly (35959) to the 2-pin connector on the alarm assembly, connect the 14-pin connector to P9 on the power board, and connect the Molex connector to the solenoid.
9. Re-assemble the right and front modules to the unit per Chapter 7 of this manual.
10. Complete operational checks to verify correct operation.

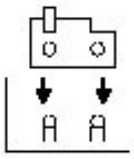


FIGURE 8-9 ALARM ASSEMBLY PLACEMENT

8.8.2 PROCEDURE FOR UNITS WITH POWER BOARD 35950 AND OLD STYLE ZERO BOARD (35937)

8.8.2.1 EQUIPMENT REQUIRED

- 1002125-Adapter Cable PLV's w/o Alarm PCB
- 98558-Pin Extractor, HT 2285
- F1000711-Kit, PLV Alarm Replacement

8.8.2.2 PROCEDURE

1. Lower the right and front modules according to the instructions in Chapter 7 of this manual.
2. Remove and discard the two screws that secure the old style alarm to the unit whether it is the alarm block, or alarm PCB. If there is a gasket located between the alarm and the front panel, discard it. Using a pin extractor (98558) extract the red and black wires coming out of the alarm from the 3 pin Molex connector. (Leave purple wire in place.)
3. Remove and discard the two stand-offs from the front panel that the alarm was secured to.
4. Screw the new stand-offs (35042) from the alarm replacement kit onto the front panel PEM studs.
5. Place the new Alarm Assembly onto the stand-offs. See Figure 2-9 for alarm placement.
6. Secure the alarm assembly to the stand-offs with the two washers and screws provided in the replacement kit.
7. The alarm is a critical component. Document the alarm change and lot code of the alarm.
8. Connect the adapter cable (1002125) to the 2-pin connector on the alarm assembly. Place the red wire into pin 1 on the Molex connector, and the black wire into pin 2. Be careful not to damage the purple wire in pin 3. Plug the Molex connector to the zero board connector.
9. Re-assemble the right and front modules to the unit per Chapter 7 of this manual.
10. Complete operational checks to verify correct operation.

8.8.3 PROCEDURE FOR UNITS WITH POWER BOARD 35903 AND OLD STYLE ZERO BOARD (35937)

8.8.3.1 EQUIPMENT REQUIRED

- 1002125-Adapter Cable, PLV's w/o Alarm PCB
- 98558-Pin Extractor, HT 2285
- F1000711-Kit, PLV Alarm Replacement
- F35950-Assembly, PWR BRD, PLV-100 New Style

8.8.3.2 PROCEDURE

1. Lower the right and front modules according to the instructions in Chapter 7 of this manual.
2. Remove and discard the two screws that secure the old style alarm to the unit whether it is the alarm block, or alarm PCB. If there is a gasket located between the alarm and the front panel, discard it. Using a pin extractor (98558) extract the red and black wires coming out of the alarm from the 3 pin Molex connector. (Leave the purple wire in place.)
3. Remove and discard the two stand-offs from the front panel that the alarm was secured to.
4. Screw the new stand-offs (35042) from the alarm replacement kit onto the front panel PEM studs.
5. Place the new Alarm Assembly onto the stand-offs. See Figure 2-9 for alarm placement.
6. Secure the alarm assembly to the stand-offs with the two washers and screws provided in replacement kit.
7. The alarm is a critical component. Document the alarm change and lot code of the alarm.
8. Connect the adapter cable (1002125) to the 2-pin connector on the alarm assembly. Place the red wire into pin 1 of the Molex connector, and the black wire into pin 2. Be careful not to damage the purple wire in pin 3. Plug the Molex connector to the zero board connector.
9. If the unit still contains power board 35903, replace it with the F35950 power board. Refer to 7.22 35903 Power Board Retrofit and choose the appropriate level for instructions and parts needed.
10. Re-assemble the right and front modules to the unit per Chapter 7 of this manual.

11. Complete operational checks to verify correct operation.

8.9 INSPECTION OF ALARM MODULE F1000711

The purpose of this procedure is to evaluate and verity the integrity of the solder connections of the alarm component pins to the printer circuit board.

Follow all applicable disassembly and assembly instructions per guidelines found in Chapter 7 using the recommended tools and equipment.

8.9.1 PROCEDURE

8.9.1.1 TESTING PROCEDURE

1. Prior to inspection of the Alarm Module (F1000711), verify the functionality by allowing the unit to go through its self diagnostics test. Record the test results (pass/fail) of the alarm functionality in the task notes section of the service notification and code damage and cause codes appropriately.

NOTE

Review the complaint history to determine if the alarm inspection has already been completed. If it is documented in the task notes section of the service notification that 2003-08, 2005-44, or 2006-02 has been performed, verify that the diagnostic test results have been entered, and service the unit per service manual guidelines.

NOTE

If part number 1014245 is lot coded in class overview, the inspection of the alarm module does not need to occur.

2. If a failure of the alarm is detected, replace the Alarm Module (F000711) with the latest version of (F100711 containing 1014245). Perform all necessary testing per service manual instructions.
3. The inspection procedure listed below, will then not be necessary except to complete the service notification with the appropriate information and return the module.

8.9.1.2 INSPECTION OF ALARM MODULE

1. Remove PLV unit's recessed feet & screws. Set aside fee; scrap the 4 screws (98807).
2. Remove bottom panel and set aside.
3. Remove the Alarm Module and inspect the solder connections of the alarm component pins to the printed circuit board.
4. Determine if there are any anomalies of solder joints (e.g. open connections, poor workmanship, incomplete solder fill). Refer to Figure
5. Record the lot number of the Alarm Module inspected along with the serial number of the PLV unit in the Service Notification.
6. Replace the existing Alarm Module if necessary; otherwise reinstall the existing Alarm Module if it meets specifications.
7. Replace the bottom panel, new screws and feet of the unit.

8. Record in the task notes section of the service notification that you inspected the alarm module solder joints per 2003-08, 2005-44, or 2006-02 (pass/fail).
9. Return all failed Alarm Modules to:

Respironics Quality Assurance
101 Murry Ridge Lane
Murrysville, PA 15668

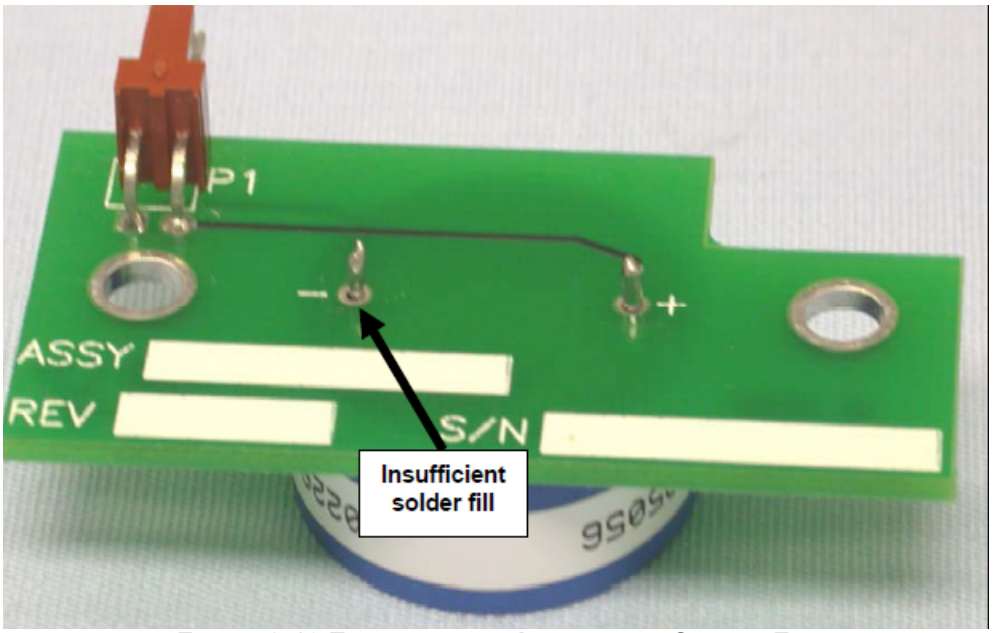


FIGURE 8-10 EXAMPLE OF AN INSUFFICIENT SOLDER FILL

8.10 FC2002-06: LOGIC BOARD 35916

An engineering change order was written in 1992 for a modification of certain revisions to Logic Board 35916. ECO 2688 stated:

On the circuit side of the PCB, cut the trace landing to pin 11 of U27. Jumper pins 11 and 12 of U27 using 24 gauge Buss Wire.

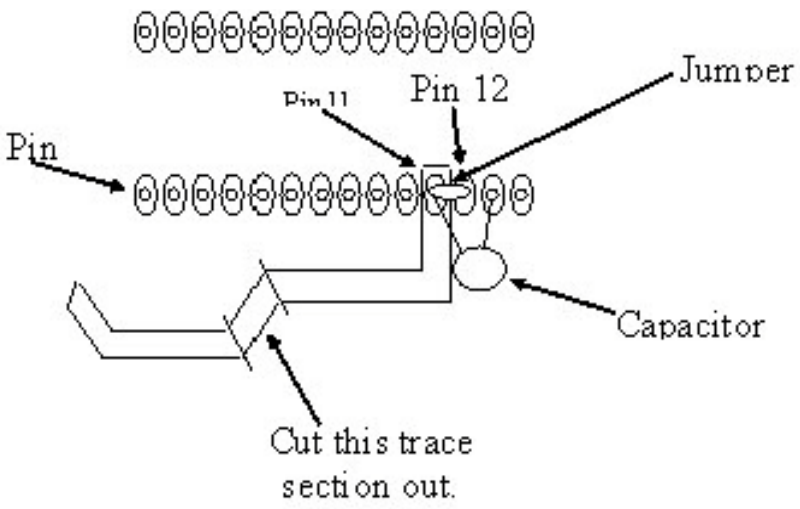


FIGURE 8-11 CIRCUIT SIDE OF U27 (ADC)

This ECO will need to be performed if an upgrade from power board 35903 to F35950 is being performed. If it is not performed, a 1.0 reading in the volume window and intermittent failures may arise. Only certain revisions of this logic board require this ECO. To establish which revision you have, remove the top panel from the unit. Look down between the logic board and front panel. Just to the left of the white plastic stand-off of the spontaneous LED you will see a disk type capacitor soldered on to the logic board. If the cap is not present, then this ECO does not need to be performed. If the cap is present, then look for the solder bridge explained above. If the bridge is there, this ECO has been done. If the bridge is not there, the ECO will need to be done to improve reliability.

8.11 PLV, RFI ASSEMBLY MOUNTING STUD PROTECTION

The following procedure provides instructions for adding tubing to the RFI Assembly mounting studs used when mounting the RFI Assembly to the back panel of all PLV Domestic and International Models. The addition of the stud tubing prevents stud contact with the internal battery. Tubing should be added during the next scheduled maintenance interval.

8.11.1 EQUIPMENT REQUIRED

- RFI Mounting Stud Tubing - contains two 1/4 inch tubes (1026497)

8.11.2 PROCEDURE

1. Refer to Chapter 7 to access the inside back of the back panel.
2. Locate the rear of the RFI Assembly Mounting and place the stud tubing from the RFI Mounting Stud Tubing (1026497) over the threads of both mounting studs.
3. Reassemble the PLV and proceed with scheduled maintenance and/or testing.

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CHAPTER 9 RUN IN

9.0 RUN-IN REQUIREMENTS

Complete the run-in requirements.

9.0.1 PREVENTIVE SERVICE

Twelve hours total run-in time is required if the PLV-100 only received Preventive Service.

If the PLV-100 received Preventive Service and required the installation of any ECO (other than cosmetic) or the replacement of a major component or assembly, refer to General Service for run-in time required.

9.0.2 GENERAL SERVICE

Twenty-four hours total run-in time is required if the PLV-100 received any General Service or had an ECO installed during this service.

NOTE

Ninety-six hours total run-in is required if the ball screw assembly was replaced during General Service.

9.0.3 NO PROBLEM FOUND

If no problem was found with the PLV-100, operate the unit at the parameters at which the customer reported the problem. It may be necessary to operate these units for an extended period of time in order to diagnose an exhibited failure.

9.1 GUIDELINES

If more than one category applies, the longest applicable run-in time is required. If service does not apply to any of the above categories, no run-in time is required.

If the run-in is stopped for repair, the stop run-in time and date are recorded, the necessary repairs made, and the run-in is restarted from zero hours and documented.

Run-in times listed are normal minimum times, and may be terminated by no more than 10%, if required. There is no maximum run-in time.

Perform the Quality Assurance Final Inspection as applicable following any Preventive Service, General Service, or repair of a device or an accessory.

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CHAPTER 10 CALIBRATION AND TESTING

10.0 CALIBRATION

Every effort is made at Respironics during the manufacture of the PLV-100 to ensure that the performance of the device is well within stringent specifications set by the Respironics Quality Assurance Program. However, if it is determined by the technician that it is necessary to re-calibrate the device, proceed using the following procedures.

10.1 INTERNAL AND ALARM BATTERY/CAPACITOR CHARGING AND TEST

Perform the following internal battery test during run-in, anytime after the unit has a minimum of two hours accumulated run-in time, and there is at least two hours run-in time remaining.

10.1.1 EQUIPMENT REQUIRED

- Jumper Wire
- Voltmeter

10.1.2 PROCEDURE

1. Set the operating parameters as follows:
   - TIDAL VOLUME = 2.10 liters
   - RATE: PATIENT BPM = 10 BPM
   - INSPIRATORY FLOW = 60 LPM
   - Back pressure = 30 to 50 cm H_2O
2. While the unit is being run-in, pull out the VAC circuit breaker. Observe the ventilator for the low battery alarm.
3. If the low battery alarm sounds in less than 45 minutes, replace the batteries. The replacement batteries must also be tested using this test. If two sets of batteries fail in the same unit during this service, test the unit to determine if another problem exists.
4. If the ventilator runs at least 45 minutes without sounding the low battery alarm, the internal batteries are considered adequate for use until the next time the ventilator is serviced.
5. Push in the VAC circuit breaker to reset, and continue the run-in for a minimum of two hours to recharge the internal batteries.

10.1.3 ALARM CAPACITOR TEST (FOR UNITS WITH LATER VERSION POWER BOARD F35950)

Turn on the unit. Pull out the VDC circuit breaker. This causes the alarm to sound. At the same time, start a stopwatch. The alarm must sound for a minimum of five minutes.

10.2 ZERO REFERENCE SOLENOID VALVE

10.2.1 EQUIPMENT REQUIRED

- Test Syringe

10.2.2 PROCEDURE

1. Connect a test syringe, (Figure 5-1), to the PAP outlet. Apply a minimum of 5 cm H_2O pressure to the PAP assembly using the syringe.
2. Turn on the unit. The unit should run through the diagnostic check and begin breath delivery. If the unit continues running through the diagnostic check and does not begin breath delivery, the solenoid valve is malfunctioning and requires replacement. Turn the unit off.

10.3 DIAGNOSTIC CHECK

Turn on the unit. A brief alarm sounds, produced by the hardware reset pulse generated at start-up. Then 8's appear in all LCD positions, following which all the LEDs illuminate sequentially. Finally, “0.0” appears in the TIDAL VOLUME digital display window.

10.4 DIAGNOSTIC ALARM

At the end of the diagnostic check, a slightly longer alarm sounds. This tone is produced by software, and tests different circuitry than the hardware alarm. The unit then begins delivering breaths as determined by the front panel settings.

10.5 AC OPERATION

When operating the unit on AC power, the green LED on front panel is illuminated.

NOTE

On International 100/220/240 VAC units (except German) the green power source VAC LED must light when the unit is plugged into a 100/220/240 VAC power source ***and with the unit turned off****. When the unit is unplugged from a 100/220/240 VAC power source, the green power source VAC LED must stay lit between 5 and 15 seconds.*

On all 120 VAC units the green power source VAC LED ***must not light*** *when the unit is plugged into a 110 VAC power source.*

10.6 TIDAL VOLUME DISPLAY RANGE

Turn the TIDAL VOLUME knob on the ventilator completely counterclockwise. The unit displays 0.05 liters. Turn the knob completely clockwise. The unit displays 2.99 liters.

10.7 RATE: PATIENT BPM DISPLAY RANGE

Set the TIDAL VOLUME to 0.40 liters (0.30 liters if a 30 BPM PLV-100 is being tested). Turn the RATE: PATIENT BPM knob completely counterclockwise, and then completely clockwise. The unit must display the range between 2 and 40 BPM ± 2 BPM (between 2 and 30 BPM ± 2 BPM if a 30 BPM PLV-100 is being tested.).

10.8 INSPIRATORY FLOW RATE DISPLAY RANGE

Turn the INSPIRATORY FLOW knob completely counterclockwise, and then completely clockwise. The unit must display the range between 10 and 120 LPM.

10.9 I:E Ratio Display Range

Adjust the following knobs: TIDAL VOLUME, RATE: PATIENT BPM, and INSPIRATORY FLOW to check that the I:E RATIO displays a range between 1:0.3 and 1:9.9 LPM.

10.10 Internal Battery Operation

Pull out the VAC circuit breaker. The power LED changes from green to amber within six seconds, and the 3-second alarm sounds. Allow the PLV to complete one breath. Rock the battery test switch to the up position. The reading in the INSPIRATORY FLOW window must read 11 volts or greater.

10.11 External Battery Operation

Connect a 0-12 volt adjustable DC power supply to the front panel battery connector. The power LED changes from green to clear, and the 3-second alarm sounds. Rock the battery test switch to the bottom position. Allow the PLV to complete one breath. The reading in the INSPIRATORY FLOW window must read 11 volts or greater.

10.12 Low Voltage Alarm Test

10.12.1 Equipment Required

- 12 Volt Adjustable Power Supply
- Voltmeter

10.12.2 Procedure

1. Set BPM to 2.
2. Connect the black lead of a voltmeter to ground (TP2), and the red lead to line voltage (TP5).
3. Slowly decrease the voltage of the 0-12 volt adjustable DC power supply. The unit must start sounding an alarm at approximately 9.5 VDC, as indicated by the voltmeter. The alarm increases in volume as the voltage drops below 9.5 VDC.

NOTE

Line voltage is pulled down during piston movement. ***Measure the DC voltage when the piston is stationary.***

4. If the unit is not alarming at 9.5 VDC, adjust R21 on power board 35903, or R36 on power board F35950, clockwise until the unit sounds the alarm at 9.5 VDC.

10.13 Low External Battery Test

10.13.1 Equipment Required

- 12 Volt Adjustable Power Supply
- Voltmeter

10.13.2 Procedure

1. Connect a 0-12 volt adjustable DC power supply to the front panel outlet. Pull the VAC circuit breaker out.

2. Continue to slowly lower the voltage by adjusting the knob on the power supply. Disregard the low voltage alarm that is sounding. The external battery light starts flashing indicating that the external voltage is getting low.
3. The unit switches to internal batteries at approximately 8 VDC with the amber light (internal battery) illuminating and the clear light (external battery) still flashing. When the power source changes, an alarm sounds for 1-2 seconds indicating that the unit is now running on internal batteries.
4. Push in the AC circuit breaker and disconnect the DC power supply.

10.14 Power Failure Alarm Test

Pull out the VDC (5 amp) circuit breaker. The unit sounds a constant alarm. Push in to reset the VDC circuit breaker.

10.15 Reverse Battery Test

10.15.1 Equipment Required

- 12 Volt Adjustable Power Supply
- Reverse Battery Cable (90027)

10.15.2 Procedure

Connect the reverse battery cable assembly (90027) to the DC receptacle on the front panel. Check that the unit alarms. Disconnect the reverse battery cable.

10.16 Power Board Voltages

10.16.1 Equipment Required

- Voltmeter

10.16.2 Procedure

There are two styles of power boards. The earlier version power board (35903) is identified by eight test points along the top edge of the board. The later version power board (F35950) is identified by twelve test points along the top edge of the board. Refer to Table 2-1 for specifications for each of the test points.

1. Check the voltages on the power board.
2. Using a voltmeter, connect the black lead to ground (TP2) and the red lead to each test point, one at a time, to check specifications.

TEST POINT	VOLTAGE NAME	UNIT	SPEC.	ADJUST
TP1	*Internal Charging*	*off/fuse out*	*13.50 - 13.80 VDC*	*R51*
TP2	*Ground*	*plugged in*	*none*	*none*
TP3	*Raw*	*off/plugged in*	*18.0 - 26.0 VDC*	*none*
TP4	*External Charging*	*off*	*13.90 - 14.30 VDC*	*R37*
TP5	*Line Voltage*	*on*	*13.45 - 14.95 VDC*	*R36*

TEST POINT	VOLTAGE NAME	UNIT	SPEC.	ADJUST
TP6	*Alarm Capacitor*	*off*	*4.50 VDC minimum*	*none*
TP7	*+5 Volt Analog*	*on*	*4.90 - 5.10 VDC*	*none*
TP8	*+5 Volt Digital*	*on*	*4.80 - 5.20 VDC*	*none*
TP9	*+5 Volt Transducer*	*on*	*4.95 - 5.05 VDC*	*none*
TP10	*P X 10 Voltage*	*on*	*2.65 - 2.80 VDC with no pressure*	*none*
TP11	*P X 1 Voltage*	*on*	*2.80 -2.95 VDC at 25cm 1.30 - 1.40 VDC at 0 cm*	*R22 R23*
TP12	*Dump Circuit*	*on*	*0.80 - 1.0 VDC at 0 cm 2.50 - 2.70 VDC at 95 cm*	*R2 R1*
Anode of CR10	*15-volt Regulator*	*on*	*14.25 - 15.75 VDC*	*none*

TABLE 10-1 LATER VERSION POWER BOARD (F35950)

10.17 CHASSIS GROUND TEST

10.17.1 EQUIPMENT REQUIRED

- Voltmeter

10.17.2 PROCEDURE

1. Turn on the unit. Connect the leads from a multimeter to the power board using a 1 Meg ohm shunt. Connect the black lead (negative) to ground (TP2) and the red lead (positive) to the chassis. The multimeter reading should not exceed 1.0 VDC. Turn off the unit, remove the shunt and disconnect the unit from the AC power source. Change the meter to the highest ohms scale (200 KΩ), the meter should read infinite.
2. Set the operating parameters at 0.50 liters, 10 BPM, and 30 LPM.

10.18 UNIT CALIBRATION

10.18.1 EQUIPMENT REQUIRED

- Test Syringe
- RT-200A
- Gate Valve (F90902)

10.18.2 PROCEDURE

Perform the following steps for unit calibration

10.18.2.1 CONTROL MODE OPERATION

1. Set the MODE knob to the Control position. Adjust the operating parameters to the following:
   - TIDAL VOLUME = 1 liter

- RATE: PATIENT BPM = 10 BPM
- INSPIRATORY FLOW = Approx. 46 (adjust until I:E Ratio is 1:2.0)

2. Operation parameters must be consistent with front panel settings. Cylinder pullback must be slow. The next breath delivery begins immediately at the end of the cylinder pullback.

10.18.2.2 PAP LEAKAGE CHECK

1. Connect a 60 cc test syringe to the front panel of the PLV-100, (see Figure 5-1). Apply 40 cmH_2O pressure to the PAP assembly using the syringe.
2. The pressure in the PAP assembly tubing must not drop more than 6 cmH_2O in 30 seconds. If the pressure drops more than 6 cmH_2O, check the “tee” assembly, the gauge straight connector, or the PAP outlet for leakage.

10.18.2.3 CYLINDER LEAKAGE CHECK

1. Set the volume to 1.80 liters, rate to 10 BPM, and flow to 84 LPM (I:E ratio reads approximately 1:2.0). Attach an RT-200A, (or equivalent volume measuring device) and a gate valve (F90902) to the patient air outlet. Fully open the gate valve, (pressure on unit gauge reads less than 10 cmH_2O. Allow a few breaths for the unit to stabilize, then measure the volume of five breaths.
2. Gradually close gate valve until the pressure measured on PLV-100 manometer gauge peaks at 40 cmH_2O.
3. Measure the volume of five breaths at 40 cmH_2O pressure. Subtract the volumes at 40 cm from the volumes with no pressure. The difference must be less than 0.35 liters (0.07 per breath).

10.18.2.4 HIGH VOLUME CALIBRATION

1. Set the volume to 2.70 liters, rate to 10 BPM, and flow to 120 LPM. Allow the unit to stabilize at these settings for approximately five breaths. Measure one breath using an RT-200A, (or equivalent measuring device).
2. The volume must be between 2.43 and 2.97 liters. Adjust the V trim potentiometer (R18), on top of the digital board, clockwise to increase the volume or counterclockwise to decrease the volume. The unit must be turned off and then back on each time these pot settings are changed.

10.18.2.5 LOW VOLUME CALIBRATION

1. Set the volume to 0.05 liters, rate to 10 BPM, and flow to 10 LPM. Allow the unit to stabilize at these settings for approximately five breaths. Measure ten breaths using an RT-200A, (or equivalent measuring device). Divide the total volume by 10. The volume must be between 0.03 and 0.07 liters.
2. Adjust the P trim potentiometer (R4) on the bottom of the digital board, clockwise to increase the volume or counterclockwise to decrease the volume. The unit must be turned off and then back on each time these pot settings are changed.

NOTE

If the V or P trim pot setting requires changing, repeat the low and high volume calibrations until both volumes are within specification, as one adjustment affects the other.

Turn off the unit and then back on after adjusting the V-Trim or P-Trim. This allows the microprocessor to “read” the P-Trim and V-Trim values.

10.19 Outer Limit Switch Operation Check

1. Connect a hose circuit to the patient air outlet. Disconnect the zero reference connector (green, yellow, and orange wires) at the bulkhead. This causes the piston to travel past zero and contact the bulkhead push-button switch, sounding an alarm.
2. Reconnect the cable. Increase the TIDAL VOLUME to 2.99 liters causing the piston to contact the micro switch, sounding an alarm.
3. Decrease the TIDAL VOLUME to 2.80 liters, the outer limit alarm must not sound. Bend the wand on the outer limit switch to meet these requirements.

10.20 Pressure Relief Valve Operation Check

10.20.1 Equipment Required

- Test Circuit
- 1/4” Nut Driver
- RT-200A

10.20.2 Procedure

1. Connect a test circuit with test lung (if using the TSI Certifier, connect a restrictor instead of the test lung RI#1016583) and the Magnehelic gauge (or similar gauge capable of reading in excess of 120 cmH_2O) to the PLV-100.
2. Unplug the dump valve solenoid from P4 on the power board or add a berg jumper on J1 of power board (35950 power board only).
3. Turn the pressure vent shaft completely clockwise.
4. Turn on the unit. Adjust the operating parameters as follows:
   - MODE = Control
   - TIDAL VOLUME = 0.7 liters
   - RATE: PATIENT BPM = 7 BPM
   - INSPIRATORY FLOW = 10 to 40 LPM
5. For units with the Vent Assembly (Figure 7-5), place a finger over the small hole in the vent body of the vent assembly, opposite from the pressure switch. This prevents a small air leak. Listen for the pressure relief valve to release pressure between 105 and 115 cmH_2O.
6. Exercise the valve at least one time before reading the pop-off pressure.
7. If the valve does not release pressure, turn the nut located on the inside of the valve clockwise to increase pressure with a 1/4-inch nut driver. To decrease pressure, turn the nut counterclockwise.
8. Continue to adjust and retest until the pressure relief valve releases pressure between 105 and 115 cmH_2O. Do not turn the nut in either direction more than 360°. Replace the valve if it does not release pressure after one complete revolution of the nut.
9. After successful testing of the pressure relief valve, reconnect the dump valve solenoid plug to P4 on the power board.

10.21 Pressure Gauge Check

10.21.1 Equipment Required

- RT-200A

10.21.2 PROCEDURE

Remove the restrictor if using the TSI. Disconnect the silicone tubing from the front panel pressure gauge and tee-in an RT-200A or equivalent measuring device, in parallel. Connect the end of the tubing to the pressure gauge. Adjust the volume on the unit until the pressure reaches approximately 40 cmH_2O. The reading on the unit gauge must be within 10% of the RT-200A or equivalent measuring device reading. Reconnect the tubing to the pressure gauge.

10.22 LOW PRESSURE ALARM SETTING CHECK

10.22.1 EQUIPMENT REQUIRED

- Test Circuit

10.22.2 PROCEDURE

Connect a basic patient circuit assembly, with a one liter test lung, to the patient air outlet. Disconnect the PAP line at the lung end of the circuit. Set the low pressure alarm knob to 2 cmH_2O. Blow gently into PAP tube, confirm that the 15-second alarm LED turns off at a gauge pressure of 2 ± 1 cmH_2O. Increase the setting to 40 and confirm that LED turns off at a gauge pressure of 40 ±5 cmH_2O. Reconnect the PAP line.

10.23 PRESSURE VENT LOW LIMIT

Set the volume to 0.50 liters, rate to 10 BPM, and flow to 10-40 LPM. Turn the airway pressure limit knob fully counterclockwise. The dump valve must operate between 0 and 10 cmH_2O pressure. Adjust R2 to accomplish this. Voltage must remain with in range listed previously.

10.24 PRESSURE VENT HIGH LIMIT

If using the TSI, remove the test lung and add the restrictor. Turn the airway pressure limit knob fully clockwise. Adjust the vent stop until the dump valve operates between 85 and 105 cmH_2O, as measured on the pressure gauge. See Chapter 7 for complete instructions for setting the pressure vent. For newer style units, adjust R1 on the power board to dump at 95 cm. TP12 voltage must read between 2.5 and 2.7.

10.25 CONTROL MODE OPERATION

Set the mode switch to control, sensitivity knob fully clockwise, low pressure knob to 2, and airway pressure limit knob fully clockwise. Set parameters to 0.50 liters, 10 BPM, and 40 LPM. No alarms sound. The unit must not auto cycle and the Assist/Spontaneous LED will remain off.

10.26 ASSIST CONTROL MODE OPERATION

1. Turn the mode switch to Assist Control. Turn the sensitivity knob completely clockwise causing the unit to auto cycle. The Assist/Spontaneous LED illuminates after every stroke and breath rate increases. The Tidal Volume should be set to 0.5, BPM to 10, I:E Ratio to 1:2.1, and Inspiratory Flow to 25.
2. Slowly close the PEEP valve on the test circuit until the unit stops auto cycling.
3. Slowly open the PEEP valve. The low pressure alarm LED illuminates between 2 and 4 cm H_2O pressure. Fully open the PEEP valve.

4. Gradually reduce sensitivity until the unit stops auto cycling. Add the syringe to the PAP line and squeeze the test lung to simulate a breath. The Assist/Spontaneous LED illuminates at a maximum of -0.50 cm pressure.
5. Turn the sensitivity knob completely counterclockwise. Squeeze the test lung again to simulate a breath. The Assist/Spontaneous LED illuminates at a minimum of -6.0 cm H_2O.
6. Reduce the BPM to 5 Turn the sensitivity knob to approximately the 2 o'clock position. The unit must not auto cycle. Squeeze the test lung every five seconds to simulate a breath. After five breaths the rate reads between 11 and 13 BPM.

10.27 SIMV Mode Operation

1. Set the mode switch to SIMV. The I:E RATIO displays 1:. Place a Magnehelic gauge in series with the unit pressure gauge. Squeeze the test lung every five second to simulate a breath. After five breaths the rate reads between 11 and 13 BPM.
2. Adjust the rate to 2 BPM and the low pressure knob to 20 cm H_2O pressure. The unit alarms within 20 seconds.
3. Remove the test circuit tubing from the PAP outlet and attach a syringe. Place between 18 and 22 cm H_2O pressure on the unit gauge. The unit stops alarming and the low pressure LED turns off within this range. Remove the syringe and reinstall the test circuit tubing. Adjust the low pressure knob to 2 cm H_2O pressure and adjust the operating parameters to Tidal Volume to 0.50 liters, 2 BPM, and 10 LPM. Turn off the unit and remove the Magnehelic gauge. Turn the mode switch to control and the sensitivity knob completely clockwise.

10.28 Leakage Current Check

10.28.1 Equipment Required

- SI-100 Leakage Tester

10.28.2 Procedure

Connect the AC plug into the leakage receptacle on the SI-100 leakage tester. Turn on the tester. Readings in "forward" and "reverse" must not exceed 100 micro amps. This is for 120V units only.

10.29 Ground Resistance Test

10.29.1 Equipment Required

- SI-100 Leakage Tester

10.29.2 Procedure

Connect the AC plug into resistance receptacle on SI-100 leakage tester. Turn on the tester. Probe all metal areas on outside of machine. The highest reading must not exceed 0.1 ohm.

10.30 SERVICE REQUIREMENTS

If the unit does not have an hour meter installed before this service, it is necessary to perform the following calculation to determine what the hour meter reading WILL be when motor change is required:

NOTE

Replace the motor with a new motor with a black and silver label. Refer to Chapter 6 for motor change-out requirements.

1. Multiply the time on the power meter (the one removed from the power board) by 2.7, to determine the total hours on the motor.
   - **For example:** If the power meter is reading 4,000 hours, multiply 4,000 x 2.7, to obtain 10,800 hours. The service life of a motor is 30,000 hours. Subtract 10,800 hours from 30,000 hours to find the time remaining on the motor (19,200).
2. Add 8,000 hours to the current hour meter reading to determine when the next Preventive Service Due will be, and record the hour meter reading on the “Preventive Service Due” label and attach the label to the inside of the machine air vent filter housing.
3. If the unit DID NOT require a Preventive Service, (refer to Chapter 1) DO NOT change the “Preventive Service Due” label.
4. Attach a “Motor Service Due” (35367) label to the top of the cylinder, above the Static Warning label, and write in the numbers calculated for the Motor Service Due.
5. Reassemble the top and bottom panels.
6. Review all paperwork for signatures and accuracy, before releasing the unit to QA/QC for inspection.

CHAPTER 11 OPTIONAL ENGINEERING UPDATES

11.0 RECONFIGURING THE RAAS FOR THE PLV-100

The following instructions explain how to configure power board F35950. It is identified by the presence of twelve test points located along the top edge of the board. Follow the appropriate instructions to reconfigure, as necessary.

11.0.1 LATER VERSION POWER BOARD - 12 TEST POINTS

11.0.1.1 OPTION 1

For use with Respironics Remote Alarm 34001 and 34003.

1. Place a jumper across pins 2 and 3 of J2.
2. Insert the blue wire into the pin 2 socket and the green wire into the pin 3 socket of the P8 connector.

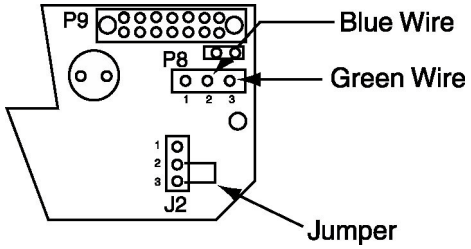

FIGURE 11-1 WIRING FOR OPTION 1

11.0.1.2 OPTION 2

For use with alarm systems requiring NORMALLY CLOSED contacts for a NO ALARM condition and OPEN contacts for an ALARM condition.

1. Place a jumper across pins 2 and 3 of J2.
2. Insert the blue wire into the pin 1 socket and the green wire into the pin 3 socket of the P8 connector.

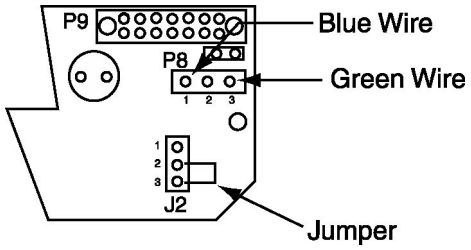

FIGURE 11-2 WIRING FOR OPTION 2

11.0.1.3 OPTION 3

Use with alarm systems requiring NORMALLY OPEN contacts for a NO ALARM condition and CLOSED contacts for an ALARM condition.

1. Place a jumper across pins 1 and 2 of J2.
2. Insert the blue wire into the pin 1 socket and the green wire into the pin 3 socket of the P8 connector

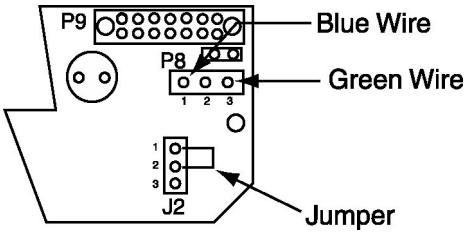

FIGURE 11-3 WIRING FOR OPTION 3

OPTION #	J2 POSITION	P8 POSITION	SWITCH, P4	OUTPUT, Z	SYSTEM REQUIRING
1	*2,3*	*2,3*	*ALARM*	*51.1 K Ohm*	*Respironics Remote Alarm*
2	*2,3*	*1,3*	*ALARM*	*CLOSED*	*Central Alarm System (Normally Closed)*
3	*1,2*	*1,3*	*ALARM*	*OPEN*	*Central Alarm System (Normally Open)*

TABLE 11-1 J2 JUMPER CONFIGURATIONS

11.1 INSTRUCTIONS FOR CHANGING THE CONNECTOR

11.1.1 EQUIPMENT REQUIRED

- Screwdriver/X-Acto Knife
- Alarm Label (35527)

11.1.2 PROCEDURE

1. Hold the connector so that the side with numbers on it is facing up. Using an X-Acto knife or screwdriver, carefully push the tab on the contact down.

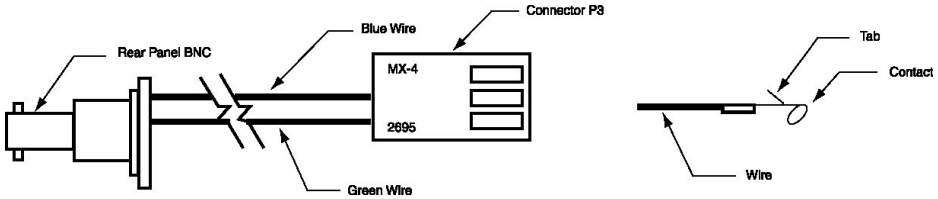

FIGURE 11-4 CHANGING THE CONNECTOR

2. Pull the wire out of the connector. The blue wire is the only one that requires moving.
3. Insert the wire into the correct socket of the connector. Firmly pull on the wire, if the wire comes free from the socket use an X-Acto knife or screwdriver to bend the tab up enough for it to catch on the socket and secure the wire in place.
4. Attach the appropriate sticker from label 35527 next to the BNC connector on the rear panel of the PLV series ventilator.

11.2 RAAS INSTALLATION PROCEDURE

The older style PLV-100 ventilator may require the installation of the RAAS option.

Remove the unit from its AC power source, and remove the 5-amp fuse from the back panel. Remove the top and bottom covers. Lower and then remove the right, and left modules, faceplate and rear module. Refer to Chapter 7 for instructions regarding removal of these items.

11.2.1 REAR PANEL

11.2.1.1 EQUIPMENT REQUIRED

- Power Drill
- ¼" Drill Bit
- ½" Drill Bit
- ½" Chassis Punch
- BNC Connector Assembly (35665)

11.2.1.2 PROCEDURE

1. Locate the lower right hand corner of the rear panel (see Figure 2-5). Remove the ribbon cable which is connected to the amp board. Close the ears of the connector to provide clearance for the tool in the following steps.

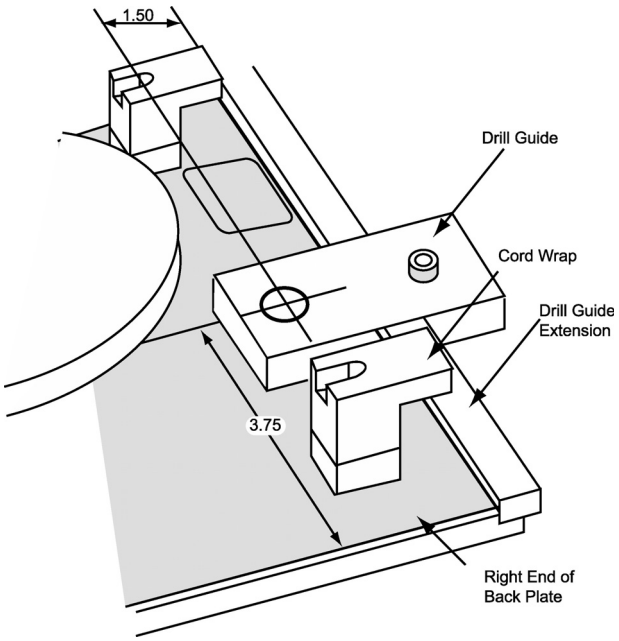

FIGURE 11-5 PLACING THE DRILL GUIDE

2. Use the remote alarm modification fixture (35T-087) as a guide for drilling the hole through the rear panel. Loosen the Allen head screw that joins the guide plates together. Place the plates over the rear panel with the drill guide positioned on the outside of the rear panel (see Figure 2-5).

3. Place the wires from the RFI assembly in the slot on the inner arm of the guide. Align the edges of the guide's outer plate and arm with the outside edge of the rear panel. The edges of the guide must be flush with the edges of the panel before tightening the tool.

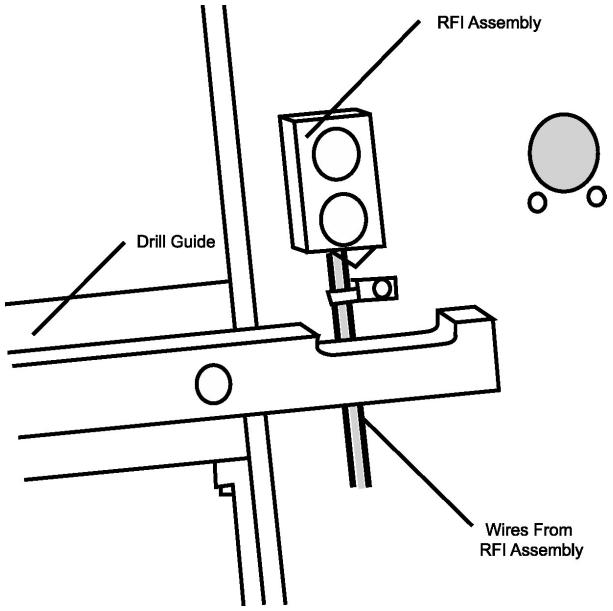

FIGURE 11-6 PLACING THE DRILL GUIDE

4. Tighten the Allen head screw to secure the guide against the rear panel. Check that the plates of the tool remain flat against the panel during tightening.
5. If the guide is not available, use a center punch to mark the rear panel according to the dimensions in Figure 2-5. Use the following procedures to drill the hole.
6. Drill a 1/4-inch (0.250") diameter hole in the back panel using the drill guide as a locator. Remove the guide from the back panel.
7. Enlarge the hole to 1/2-inch (0.500") diameter using the 1/2” chassis punch provided with the modification tools. Tighten the chassis punch from the inside of the back panel. This prevents the punch from scratching the outside surface of the panel. Clean the panel and work area of all metal shavings.
8. Remove the hex nut from the BNC connector assembly (35665) and insert the connector assembly in the 1/2-inch hole, from the rear side of the panel.
9. Check that the washer is on the connector before inserting it into the panel. Use a pair of pliers to hold the BNC connector assembly in place while tightening the hex nut with a 9/16-inch wrench.
10. Reconnect the 14-pin cable to the amp board connector on the back panel.

NOTE

The guide tool mentioned is no longer available for sale. Use the dimensions given to drill.

11.2.2 FRONT PANEL

11.2.2.1 EQUIPMENT REQUIRED

- Power Drill
- 1/4” Drill Bit
- Alarm Silence Label (35226)
- Alarm Silence Button Assembly (35664)

11.2.2.2 PROCEDURE

1. Remove the two screws that secure the nylon connector/alarm module to the lower right corner of the faceplate. Do not remove the two standoffs from the rear of the faceplate. Remove the pressure gauge from the faceplate. This prevents the gauge from being damaged due to vibration during drilling operations.
2. Place the alarm silence modification fixture, with the drill guide to the front of the panel, on the lower right corner of the faceplate as depicted in Figure 2-7. The inner plate of the guide is positioned between the DC connector and the alarm stand-offs. Gently move any wiring that blocks the inner plate.
3. The lower edge of the outer plate rests on the lower tie rod, and the step in the outer plate is flush with the right edge of the faceplate.

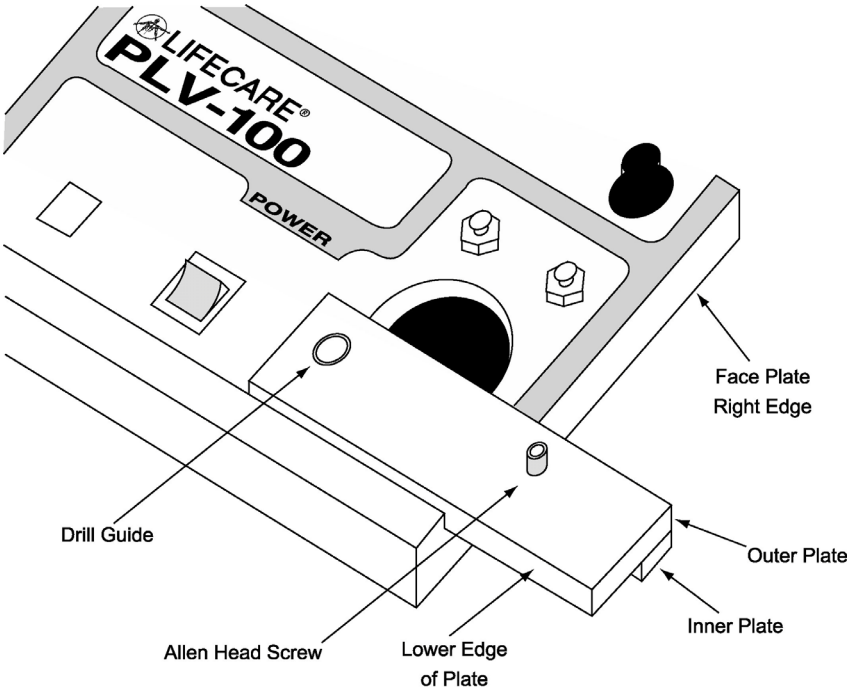

FIGURE 11-7 FRONT PANEL MODIFICATION

4. Tighten the Allen head screw against the panel. Check that the plates of the tool remain flat against the panel during tightening.

5. If not using the guide, use a center-punch to mark the front panel according to the dimensions in Figure 2-8. Place a piece of tape over the area to be drilled to protect the faceplate from damage. Dimensions on faceplate are measured without the lower tie rod on unit.
6. Drill a 1/4-inch (0.250") diameter hole in the faceplate using the drill guide as a locator. Remove the guide from the faceplate, and clean the panel and work area of all metal shavings.
7. Place the “Alarm Silence” label (35226) to the left of the newly drilled hole. Press firmly on the label to adhere to the panel.
8. Remove the trim nut from the alarm silence switch assembly (35664), and insert the switch assembly into the 1/4-inch hole from the rear of the front panel. Check that the washer is on the switch before inserting it into the front panel. Place the trim nut onto the switch and tighten to only finger tight.

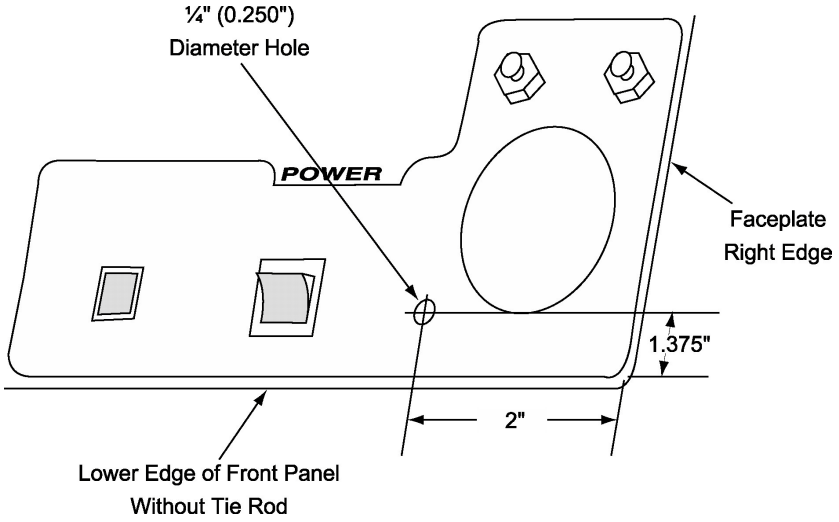

FIGURE 11-8 FRONT PANEL DRILLING DIMENSIONS

9. Reinstall the pressure gauge and the alarm module which were removed in earlier steps.

NOTE

The guide tool mentioned is no longer available for sale. Use the dimensions given to drill.

11.2.3 PCB INSTALLATION

1. Unplug the 14-pin alarm cable from the power board. Without removing the paper covering the adhesive pads, trial position the adapter board on the surface of the power board (see Figure 2-9).

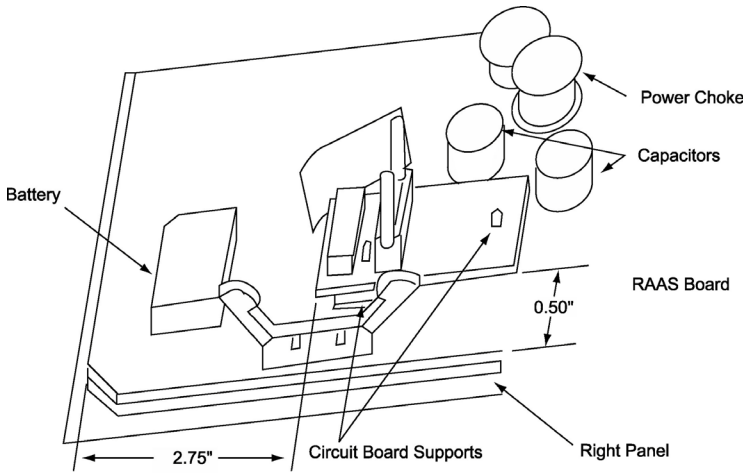

FIGURE 11-9 CIRCUIT BOARD INSTALLATION

2. Position the 14-pin connector toward the top of the power board. Place the top edge of the adapter board 2.75" from the top edge of the power board. Place the left edge of the adapter board 1/2" (0.500") from the left edge of the power board. Check that the adapter board fits in place on the power board. Remove the paper covering to expose the adhesive pads and secure the adapter board to the power board.
3. Connect the 3" long 14-pin cable from the adapter board to the 14-pin receptacle on the power board. Connect the 14-pin cable from the units alarm harness to the 14-pin receptacle (P2) on the adapter board. Connect the 4-pin cable from the silence switch on the front panel to the 4-pin connector (P4) on the adapter board. Connect the cable from the BNC remote alarm connector on the rear panel to the 3-pin receptacle (P3) on the adapter board.
4. Reassemble the modules and panels to the unit. Check that the routing of the new cables do not interfere with the mechanical operation of the unit.
5. Place the 5-amp fuse into the back panel and connect the unit to AC power. Connect a patient circuit with a test lung to the unit and turn the PLV-100 on. Allow the unit to complete its diagnostic test and begin to operate. Set the unit to control mode, and set the parameters for normal operation.
6. Disconnect the PAP line from the face of the PLV-100 to simulate a "patient disconnect". The low pressure alarm LED remains illuminated and after 15 seconds, the audible alarm sounds.
7. Press the 30-second alarm silence button on the faceplate of the PLV-100. The audible alarm turns off, the 30-second alarm silence button illuminates, and the low pressure alarm LED remains illuminated.
8. Wait for the 30-second alarm silence to expire and the alarm begins to sound. The 30-second alarm silence button extinguishes. Do not correct the fault at this time.
9. Press the 30-second alarm silence button again to silence the audible alarm. Reconnect the PAP line to the faceplate of the PLV-100. The low pressure alarm LED turns off with each breath. The 30-second alarm button remains illuminated until the 30 second time period expires, even though the alarm condition is corrected.
10. Check that the audible alarm does not sound at the end of the 30-second time period.
11. The test of the remote alarm BNC connector may be done with the unit operating as above.
12. Repeat the above test with a multimeter, set on the 200K ohm scale, connected to the BNC connector. When the PLV-100 is operating in a NO ALARM condition, the multimeter reads 51.1K

ohms. When the PLV-100 is operating in an ALARM condition, the multimeter reads “infinite” resistance. Return the PLV-100 to a NO ALARM condition and observe that the multi-meter reading drops to 51.1K ohms.

11.3 Relocating the Check Leaf Valve

11.3.1 Equipment Required

- Phillips Screwdriver
- Allen Wrench

11.3.2 Procedure

1. Remove the Motor Assembly as described in Section 7.14.
2. Remove the six nuts that secure the bulkhead assembly to the cylinder. Separate the bulkhead from the cylinder. Remove the leaf valve from the bulkhead.

NOTE

Never leave the old check leaf valve in the bulkhead assembly when fitting the new style inlet elbow and check leaf valve.

3. Observe the differences between the two faces of the baffle. One is slightly recessed, forming a lip. The baffle must be installed so that it is seated inside the recessed area.
4. Insert the check valve leaf tail into the center hole of the baffle. Pull the tail through the baffle until the check valve leaf snaps into place. Before placing the check valve inside the inlet elbow, trim off the excess portion of the tail.
5. Position the check valve inside the inlet elbow with the tail pointing away from the bulkhead, (refer to Figure 2-10). Press the part into place firmly, to ensure that it remains snug against the lip inside the inlet elbow.
6. Install the check leaf valve (33440) using the new inlet elbow (35272) onto the bulkhead inlet port.

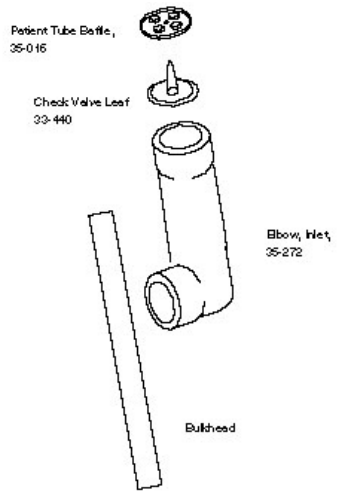

Figure 11-10 Relocating Check Leaf Valve

CHAPTER 12 THEORY OF OPERATION

12.0 POWER BOARD 35903 ASSEMBLY THEORY OF OPERATION

The Power Board Assembly manages all available sources of power for all of the electrical and electronics systems within the PLV-100. Voltage from the internal battery, from an external battery if available, and approximately 20 volts raw D.C. if the unit is plugged into utility power, are all brought through blocking diode switching logic located on the power board. These voltages are also measured by the microprocessor located on the logic board, which tests all voltages against programmed limits and ensures that power is drawn from the most reliable source available.

The microprocessor shuts down the recharger circuit for the external battery when on utility power and no battery is connected. The chargers for both internal and external batteries are shut down sequentially in hardware whenever the total current load for the instrument approaches its design limit of 5 amperes. The external battery charger will normally begin to shut down first.

12.0.1 AVAILABLE POWER SOURCES

The PLV-100 is capable of powering up directly from any available source of power. If the A.C. cord is plugged into utility power of greater than 105 volts A.C. (for 120 VAC units) when the power switch is activated, the unit should immediately execute its normal start-up procedure, light the green indicator light on the front panel and begin delivering the requested breaths.

If no utility power is available, but a charged external battery is connected to the front panel plug, the unit should start up as above except that the clear light marked “external” should come on instead of the green (AC) light. In this mode, depressing the “external battery test” switch on the front panel and holding it down during the next breath delivery should cause the actual voltage measured on the external battery plug to be displayed digitally on the flow meter display (releasing the switch returns to the flow display) Twelve or thirteen volts indicates a maximum charge on the battery. Anything 10 volts or over is acceptable for operation, while 8 volts or less indicates a dangerously discharged battery. The actual limit defined for fully discharged battery is 9.5 volts.

12.0.2 INTERNAL BATTERIES

With no external power source available, the PLV-100 will still start up on its own internal batteries, even when taken directly from the shipping carton. Here the amber front panel lamp “internal” should light before the first breath is delivered. Again, depressing the internal battery test switch will indicate the actual charge on the internal battery as described above. Failure of a unit to start-up when unpacked may indicate self-discharge of the internal battery due to excessive storage time. Units should not be left in their shipping cartons from the factory. Instead, units should be unpacked when received and stored on shelves plugged in but turned off until needed. This leaves the internal battery on a floating trickle charge which should prolong battery life indefinitely.

12.0.3 BATTERY CHARGING

Units unpacked with discharged internal batteries may be fully recoverable. Plug the unit into standard utility power and then turn the unit on. If the unit starts up normally, turn off the unit, but leave it plugged in to recharge the battery overnight. The unit should start without utility power the following morning. Two monolithic integrated circuit voltage regulators with their associated circuitry are mounted on the power board one for charging the internal and one for charging the external battery. Both of these, as well as the 15 volt regulator to supply the +LINE voltage to the motor, run off of the 20 V “+ raw” voltage taken off the bridge rectifier, CR1, located on the toroid assembly on the left module. The + raw voltage is available anytime the PLV-100 is plugged into a suitable source of utility power, which is why the internal battery is charging when the unit is

stored plugged in but turned off. The outputs of these chargers are diode blocked to prevent discharge of the batteries through the regulator circuits when utility power is not applied.

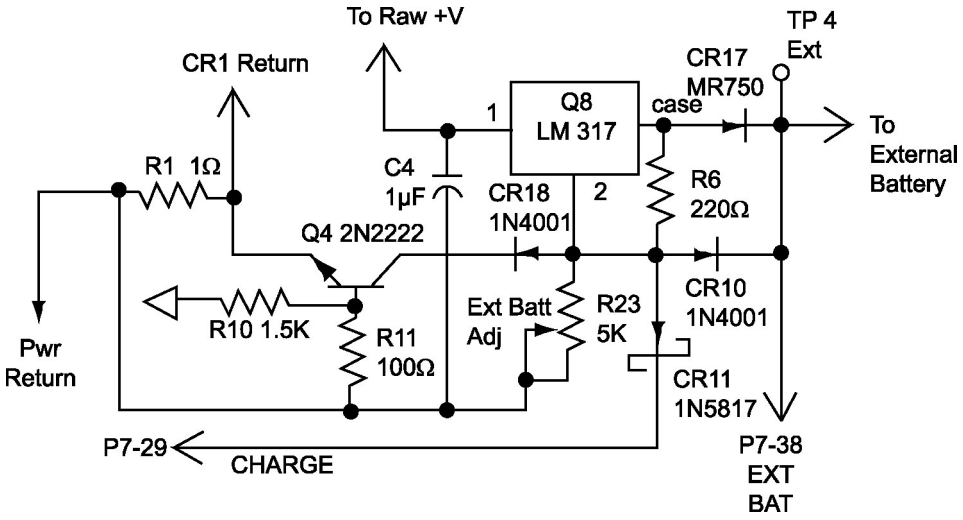

FIGURE 12-1 BATTERY CHARGING

12.0.4 EXTERNAL BATTERY CHARGING

The external battery charger, Q8, is an LM317 adjustable 3-terminal regulator, rated at 1.5A charging current, mounted in a TO-3 package. A 22-turn pot, R23, is used to adjust the output voltage at TP4, beyond blocking diode CR17, to approximately 14.25 V. CR18 and Q4 make up the overcurrent shutoff for the external charger which is explained below.

Because the available current from the toroidal transformer is limited as the motor demands more current, the battery chargers are gradually shut down to free maximum energy for the motor. Normal battery charging functions are immediately restored during the exhalation stroke.

All current delivered from the bridge rectifier CR1 via the + raw line must return to the bridge through R1, a 0.1 Ω, 7 watt wirewound resistor. The positive end of this resistor is tied to the power return line, or ground, at TP2. Thus a negative signal proportional to the + raw current appears on the negative side of R1. This signal is clamped to around 0.7V by CR1, corresponding to around 7 amperes of current from the transformer. Approximately 0.5V from emitter to base of Q4 is required for the transistor to begin to turn on, pulling down the charging voltage available to the battery. Part of this turn-on voltage is provided by the 1.5K resistor R10. The transistor is turned on the rest of the way by the negative signal across R1. Complete turn-on of Q4, or shutdown of the charger, occurs when the + raw current through R1 is about 5A (0.5V across R1). The transistor to shut down the external regulator is pre-biased with a 1.5K resistor and so it will tend to shut down with even less current than the internal charger.

12.0.5 INTERNAL BATTERY CHARGER

The internal battery charger, Q6, is an LM350 adjustable 3-terminal regulator, rated at 3.0A charging current, mounted in a TO-3 package. A 22-turn pot, R22, is used to adjust the output voltage at TP1, beyond blocking diode CR2, to approximately 14.25 V.

12.0.6 15 VOLT REGULATOR

The LM7815 regulator, Q3, is a low current, 15 volt monolithic I.C. regulator in a TO-5 package. Working in conjunction with R2 and Q5, a darlington PNP power transistor, it becomes a very high current 15 volt regulator with no degradation in regulation accuracy.

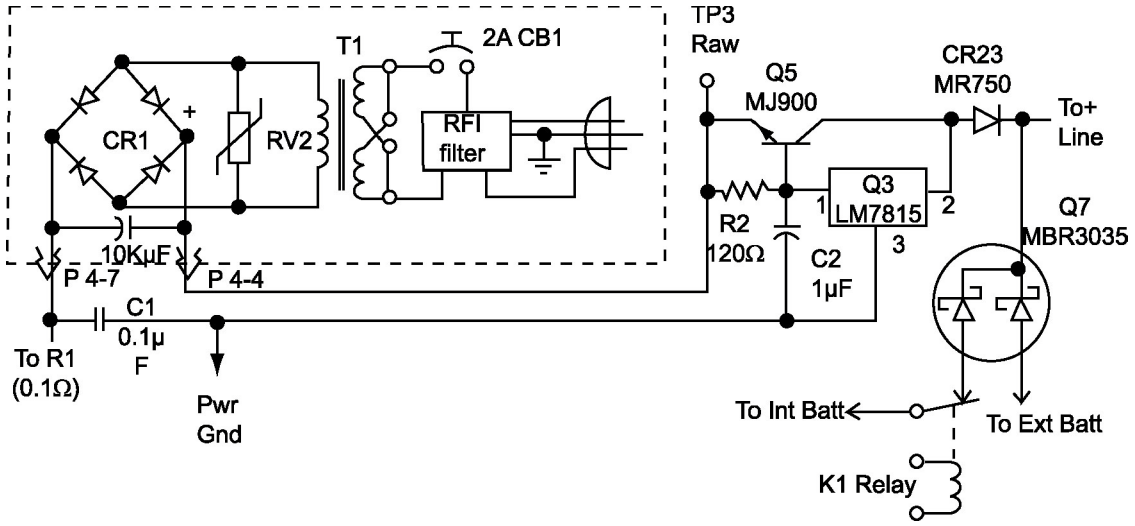

FIGURE 12-2 15 VOLT REGULATOR

Load currents up to about 10 mA are delivered exclusively by Q3; higher load currents generate enough voltage drop across R2 (approximately 1.2 volts) to start turning on the darlington transistor, Q5. Any increase in load current is then delivered solely by Q5, with the regulator needing to carry only the minute base drive current from Q5.

The lack of over-current protection in the PLV-100 is not a problem because the + raw voltage source is rather soft. Under heavy motor loads the voltage sags from around 21 volts down to perhaps 16 V. In order to maintain its 15 volt output, regulator Q3 requires about 2 volts across the I.C. plus another 1.2 volts across R2. Thus + raw must be at least 18.2 volts for a 15 volt output.

12.0.7 DIODE BLOCKING LOGIC

The output of the 15 volt regulator circuit is diode blocked by diode CR23 to prevent battery discharge into the regulator when no utility power is available. This normal silicon power diode has a forward drop of about 1.2 volts under heavy motor current loads. Therefore approximately 13.8V is available at the summing node on the 5 amp circuit breaker CB2. This voltage is diode AND'ed with the internal and external battery voltages through Q7, a common cathode dual schottky diode, each diode of which has approximately 0.5 volts of forward drop. A diode OR configuration means the highest voltage wins; the other diodes are reverse biased and deliver no current.

If the internal or external battery is fully charged and sitting at around 13 volts, then about 12.5 volts is available at the OR node. As long as the 15 V regulator is delivering 13.8 volts to the motor circuit, both sides of Q7 remain cut off and all current is delivered from utility power. However, when the + raw voltage sags under load, the 15 volt output drops below the battery voltage, whereupon CR23 cuts off and the remainder of the breath is delivered from battery power. As soon as the + raw recovers from its loading, the battery chargers turn back on and restores the charge to the batteries that was lost during the breath.

12.0.8 MICROPROCESSOR BATTERY SENSING

When the microprocessor detects the presence of an adequately charged external battery connected to the front panel, it energizes relay K1, which disconnects the internal battery from the blocking diode Q7 (but not from the internal battery charger circuit).

This allows a larger but less fully charged external battery, which can still contain many times the usable energy of the small internal cells, to carry the load, preserving internal battery capacity for emergencies. As soon as the external battery is fully discharged (to 9.5 volts at the OR node), an alarm will sound and the unit will automatically switch over to the internal battery by de-energizing K1 and allowing the higher voltage to win.

12.0.9 +5 VOLT REGULATORS

Two separate LM7805 +5 volt I.C. regulators, Q9 and Q10, are provided on the power board. Q9, whose output is marked +5V digital, supplies voltage to the pull-up resistors and two I.C.'s, U2 and U3 on the power board, and to all digital logic chips on the digital board.

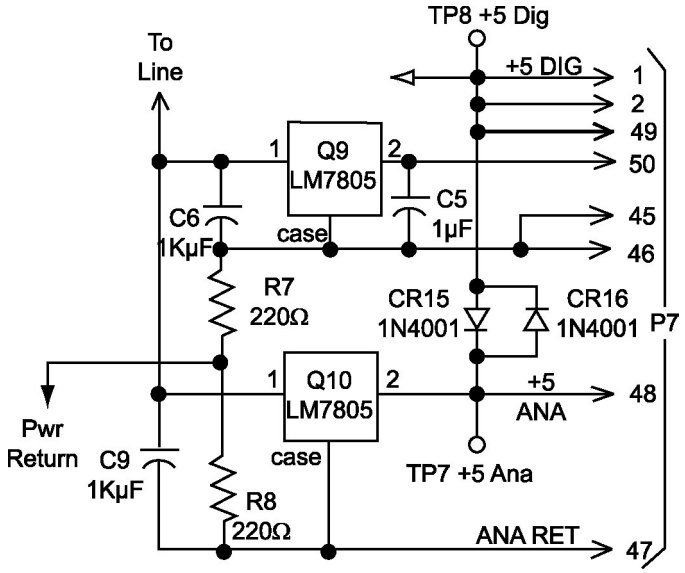

FIGURE 12-3 +5 VOLT REGULATORS

Q10, providing +5V analog, supplies the low battery alarm power on the power board and all analog reference voltages for the digital board. The outputs of the two regulators are clamped together by back-to-back diodes CR15 and CR16, so that should either regulator fail, the other can maintain functioning long enough to alert an attendant of an error condition.

All return 5 volt power from the digital board comes onto the power board on pins 11, 13, and 15 of connector P7. Digital ground sense lines are returned to Q9 on P7 pins 45 and 46, while analog ground sense is returned to Q10 on P7 pin 47. These sense lines are returned to the negative input of the 7805 regulators so that they will regulate their 5 volt outputs in reference to the ground level on the digital board, where regulation is more critical, rather than to the ground level on the power board, which may differ by several tenths of a volt. The 220 ohm resistors R7 and R8 ordinarily never carry current; they are there only to protect the power board from overvoltage when the 50-pin cable is disconnected from the digital board.

12.0.10 ALARM CIRCUITRY

Hardware alarms are generated under five different circumstances: system reset, low battery voltage, overpressure resulting in dump valve operation, loss of voltage to motor driver circuit (as in an open DC circuit breaker), and the application of a reversed-polarity external battery. Additional alarms can be generated by direct intervention of the microprocessor.

The circuits responsible for each hardware alarm are discussed in the sections which follow. All software alarms are implemented using the output port from the microprocessor that drives the ALARM signal on P7, pin 31. A TTL low signal on this line activates the alarm circuitry through the same input as the overpressure switch described below. The same line, via wired-OR open collector buffers on the digital board, produces the alarm on system reset.

12.0.11 ALARM BATTERY

The alarm battery is a three cell, nickel-cadmium battery having a nominal output of 3.6 volts, measurable directly at TP6. The battery is mounted on a circuit board, along with an op-amp, several resistors and diodes, and a transistor (see Figure 2-4). The circuit provides a “trickle-charge” to the battery, charging it only when it needs recharging.

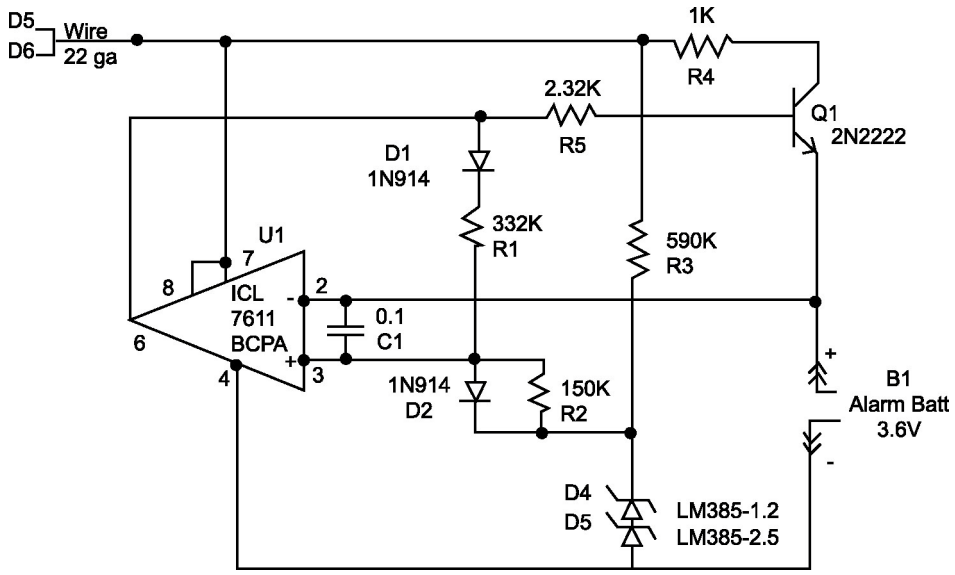

FIGURE 12-4 ALARM BATTERY CHARGER

Two voltage reference diodes, D4 and D5, supply 1.25 and 2.5 volts for a 3.75 voltage reference at U1-3. When the battery is not being charged, the voltage at U1-2 is greater than U1-3. This causes the output of the op-amp to go to a low voltage state, and D1 to be reverse biased. With no current flow through D1, D2 is also out of the circuit and the charging transistor, Q1, is turned off. A voltage of 4.2 to 4.6 is necessary at the base of Q1 for it to provide a charging current to the battery.

When the battery voltage falls below 3.7 volts, the output of the op-amp goes high. This turns on D1, D2 and Q1. D2 then provides an additional 0.4 volts to the plus side of U1. The battery is charged until its voltage at the minus side of U1, is greater than the voltage at the plus side. The op-amp is a basic comparator. When the battery voltage exceeds 4.15 volts, the op-amp turns off, which also turns off D1, D2 and Q1. The op-amp remains turned off until the battery voltage discharges to below 3.75 volts, when the cycle repeats. Since the battery is rated at 65 mA-hours and there is a 10k ohm load across it, the battery should last 180.5 hours, or

7.5 days. For this reason, it is recommended that the fuse be reinstalled in the unit as soon as it reaches its shipping destination.

Resistor R2 provides a current path which allows the voltage at the plus side of U1 to rise to 3.75 volts when D1 and D2 are back biased out of the circuit. If D1 were not in the circuit, a voltage divider would lower the voltage at the plus side of U1 to approximately 2.6 volts, which would discharge the battery.

When the output of the op-amp goes high, Q1 is turned on. The voltage across R4 can range from a low of approximately 9 volts (low internal battery condition) to about 13.5 to 14 volts. The current supplied to the battery ranges from a low of 5.25 mA to a high of 9.75 mA.

Diodes D1 and D2 have a negative temperature coefficient. The op-amp and diodes D4 and D5 have a positive temperature coefficient. The net temperature effect is -20 mV as the temperature is raised from 25 to 50 degrees Celsius.

12.0.12 LOW BATTERY ALARM

The resistor divider network, consisting of R4, R24, and pot R21, provides a sense on the +LINE voltage which operates the motor driver circuit. R21 is set so that whenever +LINE drops to 9.5 volts, the voltage on R21's wiper will be about 0.5 volts below the +5V analog reference, causing alarm transistor Q16 to start to turn on, producing a barely audible alarm. (At 9.5 volts, the analog 5 volt regulator is still operating reliably, and pulling Q16's base low will cause +5V analog at Q16 collector, directly driving the alarm).

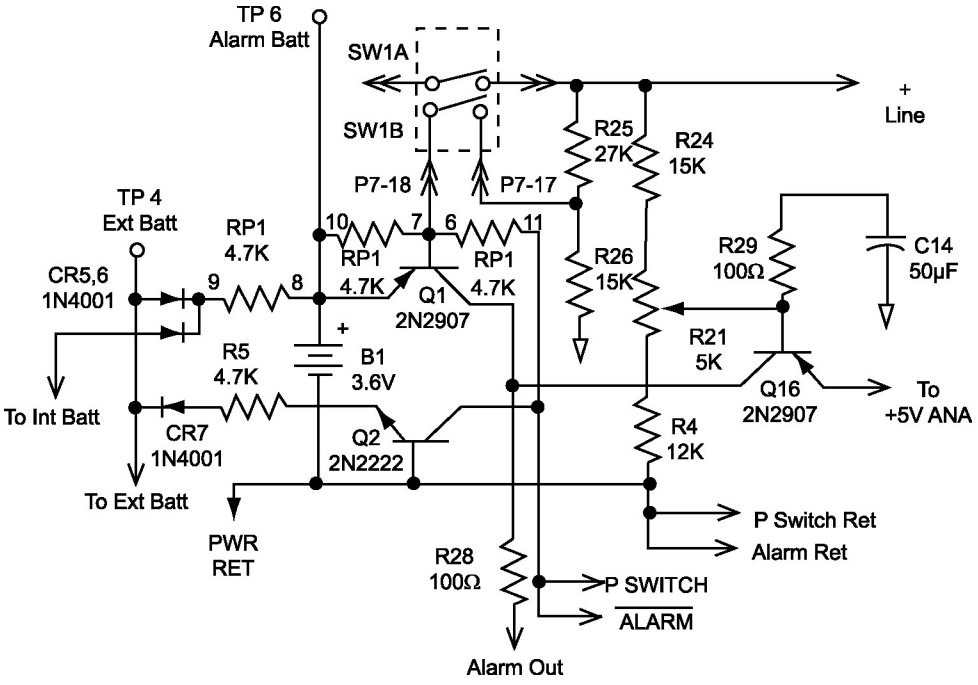

FIGURE 12-5 LOW BATTERY ALARM

12.0.13 OVERPRESSURE ALARM

The overpressure alarm circuit consists of a 2N2907 PNP transistor, Q1, and a pair of 4.7K resistors from RP1. Whenever the dump valve opens, P5 pin 1, the PSWITCH line, is pulled low, causing Q1 to turn on and applying alarm battery voltage to the alarm transducer. A time delay is built into the dump valve driver, ensuring that the alarm remains on (and the dump valve open) for 1.5 seconds. The same line can be driven low by the

microprocessor through the ALARM line on P7 pin 31. Duration (and repetition) of the alarm can then be controlled with software.

12.0.14 Reverse External Battery Alarm

The reverse external battery alarm operates when Q2 pulls the same input line to ground in response to a negative voltage applied to the positive terminal of the external battery jack. The base of Q2 is tied directly to ground and any voltage less than -1.0 volts at the cathode of CR7 will cause Q2 to start to conduct.

12.0.15 No +Line Alarm

The low battery alarm will only work when enough voltage is present at +LINE for the +5V analog regulator to operate. An additional source of alarm drive is required if the +LINE voltage fails entirely or is too low to operate the 5 volt regulators. A contact pair is provided on the power switch to connect the base of Q1 directly with a resistor divider network on the +LINE voltage. If insufficient voltage is present to operate the low voltage alarm, Q1 will turn on, applying alarm battery voltage directly to the alarm transducer.

12.0.16 Relay Driver Chip

I.C. chip U1 on the power board is an L203 containing seven darlington relay drivers, each sharing a common ground return and a common voltage flyback clamp. Only two of these drivers are actually used in the PLV-100; one to drive the relay K1 to isolate the internal battery as discussed above. The second is to operate the relief valve mounted on the back panel.

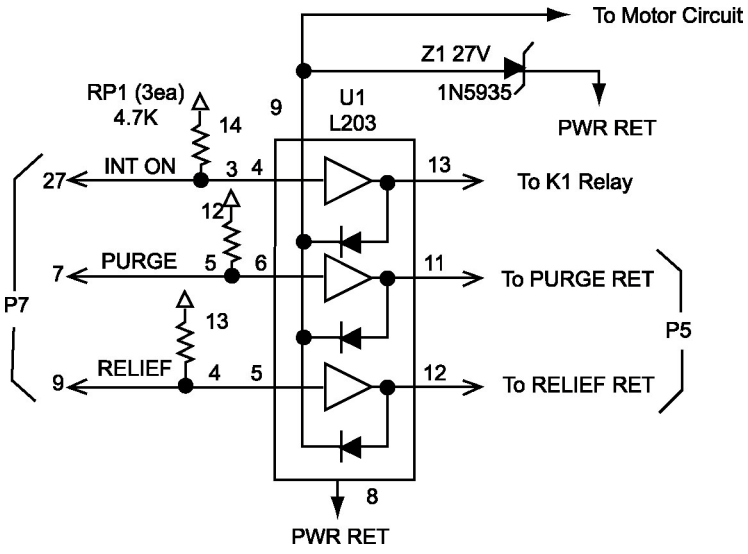

Figure 12-6 Relay Driver Chip

This valve, operated by the microprocessor approximately once every minute, applies zero pressure to the pressure transducer on the amp board, so that long term drift in the amp board amplifiers can be measured and recorded, thus enabling dynamic recalibration of the pressure system. A third relay driver in U1, marked “Purge” on the schematics, is wired for future expansion but not utilized in the current product.

12.0.17 Flyback Clamping Diode

The common flyback clamp for the relay driver chip, U1 pin 9, is a 27 volt surge suppressing zener diode Z1, which is shared with the motor driver circuit. Should any inductive flyback voltage occur as a relay coil or other

inductor is turned off, the amplitude of the voltage will be limited to a peak of 27 volts, about twice the +LINE supply voltage.

12.0.18 MOTOR DRIVE BRIDGE

The motor which operates the PLV-100 is a noninductive, bidirectional D.C. motor rated at 20 amperes, although average currents are limited to 5 amps to preserve motor life. The motor is driven from a power FET "H" bridge circuit, wherein, for the motor to drive, one upper FET and the opposite lower FET must be turned on simultaneously. When the motor is stopped, both lower FET's are turned on and both upper FET's off.

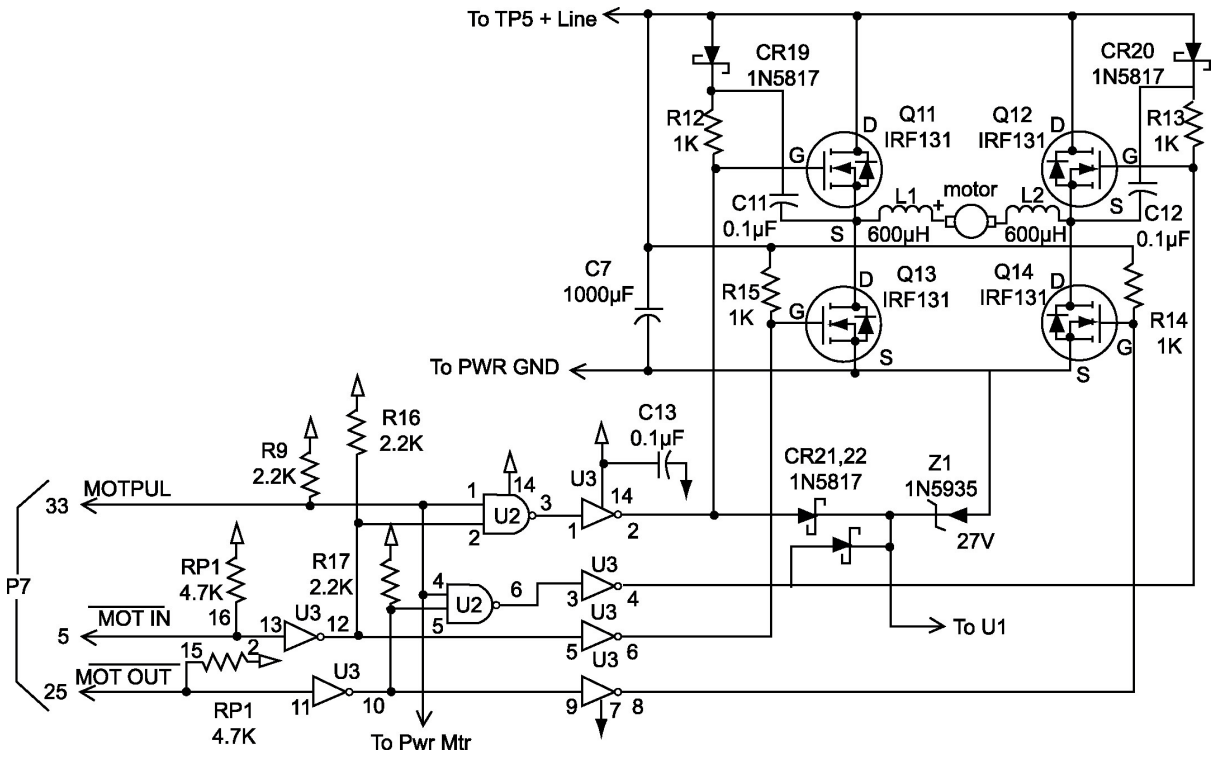

FIGURE 12-7 MOTOR DRIVE BRIDGE

Three control lines from the microprocessor on the digital board are required to operate the bridge. /MOT IN and /MOT OUT are TTL control lines that determine motor movement and direction. Only one line may be low at a time; both lines high means that the motor is stopped. MOTPUL is a pulse width modulated (PWM) signal at a frequency of 20 KHz. This signal goes high every 50 microsecond; the longer it stays high, the greater the motor torque.

In this way, a very short positive pulse every 50 microsecond yields a very low motor torque, while a very short duration of low level signal produces a very high motor torque (A 0% duty cycle simply means that the motor won't turn, while a 100% duty cycle is not permitted by the hardware design).

12.0.19 MOTOR DRIVE LOGIC

/MOT IN and /MOT OUT are inverted by two buffers in U3, a high voltage open collector hex inverter, to provide active high steering logic to the MOTPUL signal through U2 NAND gates, then re-inverted to turn off the unused lower power FET in the "H" bridge (+12 volts gate to source turns the FET's on.) Meanwhile the PWM signal MOTPUL, gated by either in or out direction signal, is re-inverted and used to power the corresponding upper FET in the bridge. Thus when MOT- IN is low, Q13 is turned off by inverter U3 pin 6, while

Q14 remains on. U2 pin 2 is high, enabling motor pulses to pass through U2 pin 3, inverted by U3 pin 2, turning on Q11. Positive voltage is then applied to the motor at P4 pin 3, and ground is provided at P4 pin 6. If /MOT IN goes high and /MOT OUT low, Q11 and Q14 are turned off and Q12 and Q13 turned on. Voltage then appears at P4 pin 6 and ground at pin 3, reversing the direction of the motor.

To provide the requisite +12 volts gate to source on the upper FET's when the source of the on FET is already sitting at nearly + line voltage, blocking diodes CR19 and CR20 and bootstrap capacitors C11 and C12 are provided. Each pulse of the 20 KHz PWM signal pumps a small charge into the gate of the on upper FET, boosting the voltage at the node of the blocking diode and the 1K pullup resistor towards 27 volts. Clamping diodes CR21 and CR22 limit the positive voltage to twice the +LINE voltage using the shared clamping zener diode Z1.

12.1 Power Board 35950 Assembly Theory of Operation

The power board assembly manages all available sources of power for all of the electrical and electronics systems within the PLV-100. Voltage from the internal battery, from an external battery if available, and approximately 20 volts raw DC if the unit is plugged into utility power, are all brought through blocking diode switching logic located on the power board. These voltages are also measured by the microprocessor located on the logic board, which tests all voltages against programmed limits and ensures that power is drawn from the most reliable source available.

The microprocessor shuts down the recharger circuit for the external battery when on utility power and no battery is connected. The chargers for both internal and external batteries are shut down sequentially in hardware whenever total current load for the instrument approaches its design limit of 5 amperes. The external battery charger will normally begin to shut down first.

12.1.1 Available Power Sources

The PLV-100 is capable of powering up directly from any available source of power. If the AC cord is plugged into utility power of greater than 105 volts AC (for 120 VAC units) when the power switch is activated, the unit should immediately execute its normal start-up procedure, light the green indicator light on the front panel and begin delivering the requested breaths.

If no utility power is available, but a charged external battery is connected to the front panel plug, the unit should start up as above except that the clear light marked "external" should come on instead of the green (AC) light. In this mode, depressing the "external battery test" switch on the front panel and holding it down during the next breath delivery should cause the actual voltage measured on the external battery plug to be displayed digitally on the flow meter display (releasing the switch returns to the flow display). Twelve or thirteen volts indicates a maximum charge on the battery. Anything 10 volts or over is acceptable for operation, while 8 volts or less indicates a dangerously discharged battery. The actual limit defined for fully discharged battery is 9.5 volts.

12.1.2 Internal Batteries

With no external power source available, the PLV-100 will still start up on its own internal batteries, even when taken directly from the shipping carton. Here the amber front panel lamp "internal" should light before the first breath is delivered. Again, depressing the internal battery test switch will indicate the actual charge on the internal battery as described above. Failure of a unit to start-up when unpacked may indicate self-discharge of the internal battery due to excessive storage time. Units should not be left in their shipping cartons from the factory for even as long as a month; rather units should be unpacked when received and stored on shelves plugged in but turned off until needed. This leaves the internal battery on a floating trickle charge which should prolong battery life indefinitely.

12.1.3 BATTERY CHARGING

Units unpacked with discharged internal batteries may be fully recoverable. Plug the unit into standard utility power and then turn the unit on. If the unit starts up normally, turn off the unit, but leave it plugged in to recharge the battery overnight. The unit should start without utility power the following morning. Two monolithic integrated circuit voltage regulators with their associated circuitry are mounted on the power board; one for charging the internal, and one for charging the external battery. Both of these, as well as the 15 volt regulator to supply the +LINE voltage to the motor, run off of the 20 V "+ raw" voltage taken off the bridge rectifier, CR1, located on the toroid assembly on the left module. The + raw voltage is available anytime the PLV-100 is plugged into a suitable source of utility power, which is why the internal battery is charging when the unit is stored plugged in but turned off. The outputs of these chargers are diode blocked to prevent discharge of the batteries through the regulator circuits when utility power is not applied.

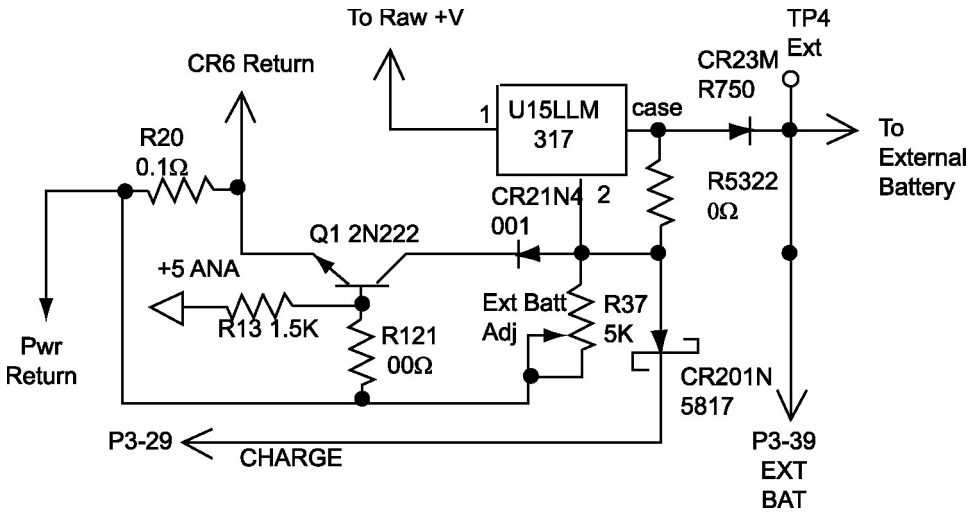

FIGURE 12-8 BATTERY CHARGING

12.1.4 EXTERNAL BATTERY CHARGER

The external battery charger, U15, is an LM317 adjustable 3-terminal regulator, rated at 1.5A charging current, mounted in a TO-220 package. A 22-turn pot, R37, is used to adjust the output voltage at TP4, beyond blocking diode CR23, to approximately 14.25 V. CR2 and Q1 make up the overcurrent shutoff for the external charger which is explained below.

Because the available current from the toroidal transformer is limited as the motor demands more current, the battery chargers are gradually shut down to free maximum energy for the motor. Normal battery charging functions are immediately restored during the exhalation stroke.

All current delivered from the bridge rectifier CR1 via the + raw line must return to the bridge through R20, a 0.1 Ω, 7 watt wirewound resistor. The positive end of this resistor is tied to the power return line, or ground, at TP2. Thus a negative signal proportional to the + raw current appears on the negative side of R20. This signal is clamped to around 0.7V by CR6, corresponding to around 7 amperes of current from the transformer. Approximately 0.5V from emitter to base of Q1 is required for the transistor to begin to turn on, pulling down the charging voltage available to the battery. Part of this turn-on voltage is provided by the 1.5K resistor R13. The transistor is turned on the rest of the way by the negative signal across R20. Complete turn-on of Q1, or shutdown of the charger, occurs when the + raw current through R20 is about 5A (0.5V across R20). The transistor to shut down the external regulator is pre-biased with a 1.5K resistor and so will tend to shut down with even less current than the internal charger.

12.1.5 INTERNAL BATTERY CHARGER

The internal battery charger, U10, is an LM350 adjustable 3-terminal regulator, rated at 3.0A charging current, mounted in a TO-3 package. A 22-turn pot, R51, is used to adjust the output voltage at TP1, beyond blocking diode CR21, to approximately 14.25 V.

12.1.6 15 VOLT REGULATOR

The LM7815 regulator, U11, is a low current, 15 volt monolithic I.C. regulator in a TO-5 package. Working in conjunction with R14 and Q3, a darlington PNP power transistor, it becomes a very high current 15 volt regulator with no degradation in regulation accuracy.

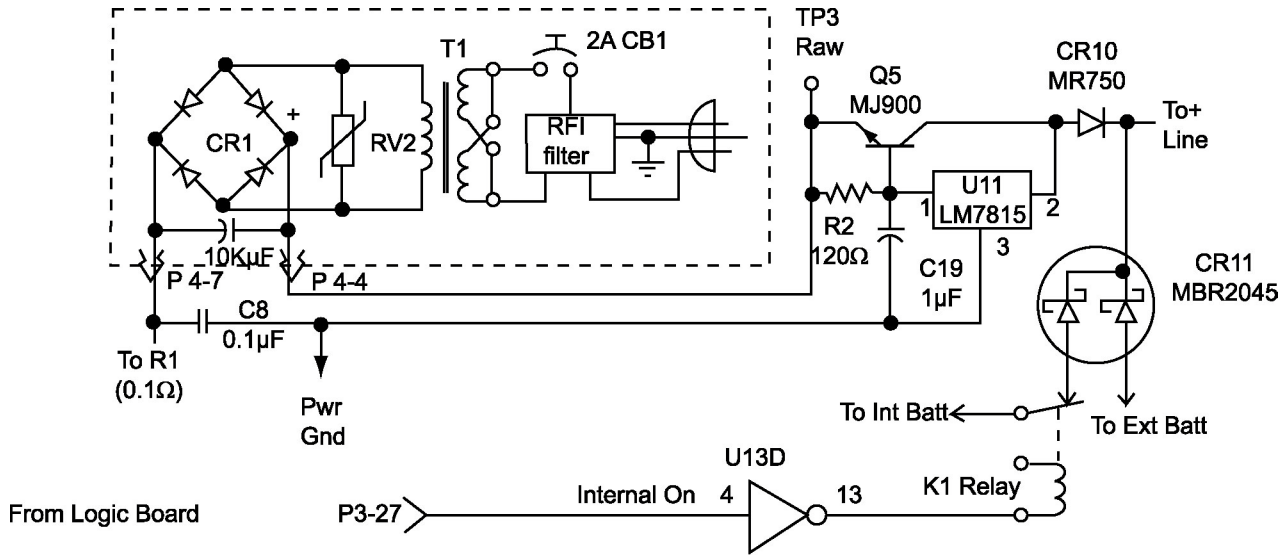

FIGURE 12-9 15 VOLT REGULATOR

Load currents up to about 10 mA are delivered exclusively by U11; higher load currents generate enough voltage drop across R14 (approximately 1.2 volts) to start turning on the darlington transistor, Q3. Any increase in load current is then delivered solely by Q3, with the regulator needing to carry only the minute base drive current from Q3.

The lack of over-current protection in the PLV-100 is not a problem because the + raw voltage source is rather soft. Under heavy motor loads the voltage sags from around 21 volts down to perhaps 16 V. In order to maintain its 15 volt output, regulator U11 requires about 2 volts across the I.C. plus another 1.2 volts across R14. Thus + raw must be at least 18.2 volts for a 15 volt output.

12.1.7 DIODE BLOCKING LOGIC

The output of the 15 volt regulator circuit is diode blocked by diode CR10 to prevent battery discharge into the regulator when no utility power is available. This normal silicon power diode has a forward drop of about 1.2 volts under heavy motor current loads. Therefore approximately 13.8V is available at the summing node on the 5 amp circuit breaker CB2. This voltage is diode OR'ed with the internal and external battery voltages through CR11, a common cathode dual schottky diode, each diode of which has approximately 0.5 volts of forward drop. A diode OR configuration means the highest voltage wins; the other diodes are reverse biased and deliver no current.

If the internal or external battery is fully charged and sitting at around 13 volts, then about 12.5 volts is available at the OR node. As long as the 15 V regulator is delivering 13.8 volts to the motor circuit, both sides of CR11

remain cut off and all current is delivered from utility power. However, when the + raw voltage sags under load, the 15 volt output drops below the battery voltage, whereupon CR10 cuts off and the remainder of the breath is delivered from battery power. As soon as the + raw recovers from its loading, the battery chargers turn back on and restore the charge to the batteries that was lost during the breath.

12.1.8 MICROPROCESSOR BATTERY SENSING

When the microprocessor detects the presence of an adequately charged external battery connected to the front panel, it energizes relay K1, which disconnects the internal battery from the blocking diode CR11 (but not from the internal battery charger circuit).

This allows a larger but less fully charged external battery, which can still contain many times the usable energy of the small internal cells, to carry the load, preserving internal battery capacity for emergencies. As soon as the external battery is fully discharged (to 9.5 volts at the OR node), an alarm will sound and the unit will automatically switch over to the internal battery by de-energizing K1 and allowing the higher voltage to win.

12.1.9 +5 VOLT REGULATORS

Two separate +5 volt I.C. regulators, U2 and U14, are provided on the power board. U2, a LM7805 mounted in a TO-3 package, whose output is marked +5V digital, supplies voltage to the pullup resistors on the power board, and to all digital logic chips on the digital board.

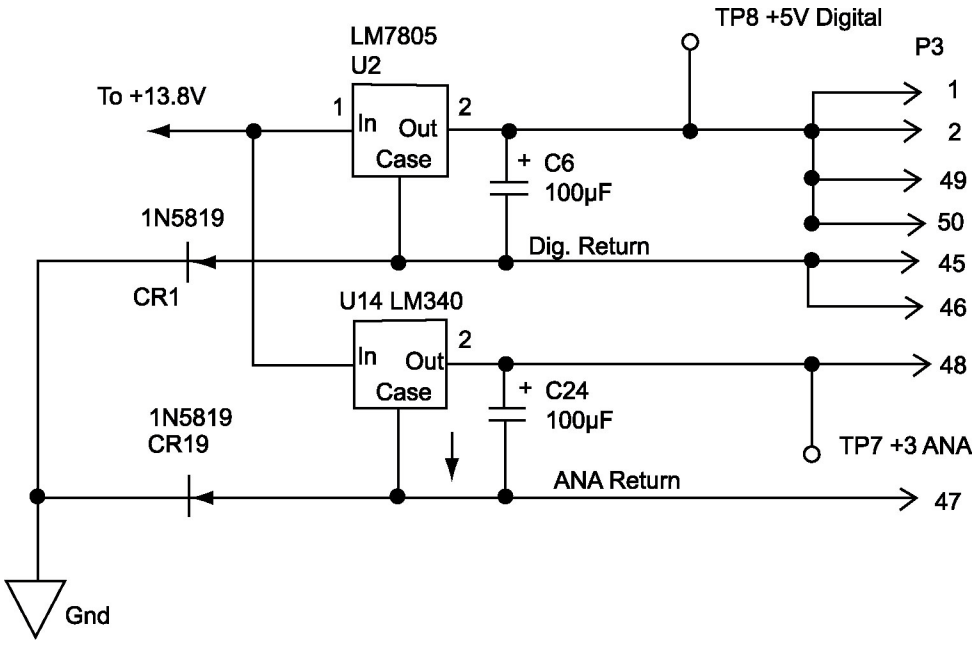

FIGURE 12-10 +5 VOLT REGULATORS

U14, a LM340 5 volt regulator mounted in a TO-220 package providing +5V analog, supplies the low battery alarm power and two I.C.'s, U5 and U6, on the power board and all analog reference voltages for the digital board.

All return 5 volt power from the digital board comes onto the power board on pins 11, 13, and 15 of connector P3. Digital ground sense lines are returned to Q9 on P3 pins 45 and 46, while analog ground sense is returned to Q10 on P3 pin 47. These sense lines are returned to the negative input of the 7805 and LM340 regulators so that they will regulate their 5 volt outputs in reference to the ground level on the digital board, where regulation is more critical, rather than to the ground level on the power board, which may differ by several tenths of a volt.

The diodes CR1 and CR19 ordinarily never carry current; they are there only to protect the power board from overvoltage when the 50-pin cable is disconnected from the digital board.

12.1.10 Alarm Circuitry

Hardware alarms are generated under five different circumstances: system reset, low battery voltage, overpressure resulting in dump valve operation, loss of voltage to motor driver circuit (as in an open DC circuit breaker), and the application of a reversed-polarity external battery. Additional alarms can be generated by direct intervention of the microprocessor.

The circuits responsible for each hardware alarm are discussed in the sections which follow. All software alarms are implemented using the output port from the microprocessor that drives the ALARM signal on P3, pin 31. A TTL low signal on this line activates the alarm circuitry through the same input as the overpressure circuit described below. The same line, via wired-OR open collector buffers on the digital board, produces the alarm on system reset.

12.1.11 Alarm Driver Circuit

The alarm circuit is powered by a one farad capacitor, C23. There is enough charge in the capacitor to operate the alarm for 40 minutes. The capacitor will recharge in seconds. During storage of the PLV-100, the capacitor will not discharge because when the main switch is “OFF”, the OP AMP U9 is disconnected from C23, preventing capacitor discharge.

The voltage for the alarm circuit is maintained at 1.235 by resistor R46 and the zener diode Z2. This reference voltage is applied to the positive input of Op Amp U9A pin 3. Any time the inverting input of U9A pin 2 is driven negative of this reference, the amplifier output pin 1 will go high and turn on U9B through R47. Q7 shorts this point to ground during alarm silence which is described in another section. The output of U9B then turns on U13C, which activates the buzzer. This signal also turns on U13B which, in turn, turns off U13A, thereby deactivating the remote alarm relay K2.

The line driving the inverting input of U9A pin 2 through R44 is normally held high by resistor R43. Various inputs to this line will cause the line to be pulled below the 1.235 volt reference, resulting in an alarm.

12.1.12 Low Voltage Alarm

A line sense on the +13.8 volt line is provided by the resistor divider network, R38, R39, and R36. R36, a 22 turn pot, is set so that whenever the line drops to 9.5 volts, the voltage on the alarm input line is pulled down to just below the 1.235 volts threshold, producing a barely audible alarm. Any line voltage below 9.5 volts will then turn the alarm on fully.

12.1.13 Power Loss Alarm

A total loss of +5 volt analog power will activate an alarm through schottky diode CR14. A TTL low signal from the microprocessor through the /ALARM signal on P3 pin 31, will sound an alarm input through CR16.

12.1.14 Dump Alarm

A dump will activate the alarm through CR18 and CR16.

12.1.15 Software Alarms

Alarms can be generated directly from the software. All software alarms are generated by the output port from the /ALARM signal on P3 pin 31. A TTL low signal on this line activates the alarm circuitry by pulling the alarm input line low through schottky diode CR16. The reset signal generated on the logic board during power up is wired (gated) into this same line. This causes the very brief alarm that sounds whenever the power switch is turned on.

12.1.16 REMOTE ALARM RELAY

A third driver in U13 operates the Dual In-line Package (DIP) relay K2. This relay is normally open, but held closed during non-alarm conditions, allowing remote sensing of a disconnected alarm cable. Another driver in U3 is simply used as an open collector logic inverter to turn off Q13, deactivating the remote alarm relay.

12.1.17 REMOTE ALARM CONNECTOR

Relay K2, the remote alarm relay, isolates the remote alarm from the system internal power supply circuits. The relay has normally open contacts which are held closed during normal ventilator operation. Any alarm condition results in the contacts opening. The rear panel BNC connector is insulated from chassis ground. Jumper J2 allows the user to select several alarm options.

12.1.18 ALARM SILENCE

A push-button switch on the front panel of the PLV-100 allows the operator to silence the alarm buzzer and the remote alarm for 30 seconds. A LED built into the alarm silence switch assembly will light during the alarm silence period.

Depressing the alarm silence switch causes a negative pulse to be coupled through C1 to the trigger input of U1-2. U1 is a NE 555 timer whose 30 second time constant is determined by C2 and R8. When activated, the positive 30 second pulse output of U1-3 turns on inverter driver U13G, which in turn, lights the alarm silence LED. This signal also turns on transistor Q7 which shorts the alarm output signal of U9A to ground, thereby inhibiting both the remote alarm and buzzer for the duration of alarm silence.

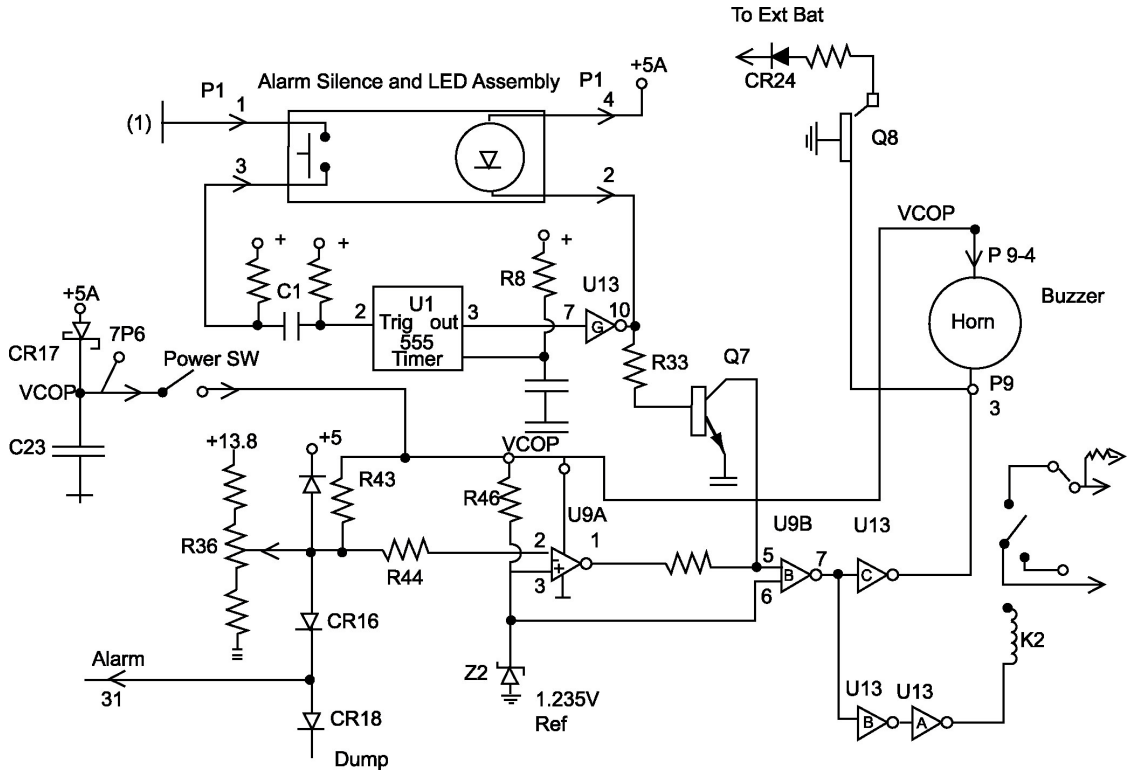

FIGURE 12-11 PLV-100 ALARM CIRCUITS

12.1.19 Overpressure Alarm

The overpressure alarm is activated each time the dump valve is opened. Two options are available. If the dump valve is driven by the FET located on the zero board, then activation is through D3 on the zero board and P5-1 to power board Berg jumper J4, then through CR16 to pull down the common alarm line described previously.

If electronic dump is being used, then CR18 pulls the common alarm point low through CR16. In this case, the dump valve is connected to P6 and driven by FET Q4 on the power board.

12.1.20 Electronic Dump

The electronic dump circuit replaces the mechanical overpressure sensing device which was mounted on the front panel. This mechanical device is replaced with a potentiometer whose limit to limit output voltage is proportional to 5 cm to 95 cm of pressure. This voltage, which represents the dump setting, is brought into the power board through P2 pin 2, then to TP12 and U8 pin 7.

U8 is a LP339 voltage comparator which compares the voltage on pin 7 with the pressure transducer U4 output which is applied to pin 6. When the two voltages are equal, the output of U8 pin 1 goes low, turning on transistor Q6 which, in turn, charges capacitor C7 through CR5 and R17. The positive charge on C7 turns on dump valve driver Q4 through isolating diode CR4.

When the pressure voltage output of U4 falls below the dump voltage setting from the front panel pot, the output of comparator U8 pin 1 goes back high, turning off Q6, leaving C7 with a positive charge. This charge holds FET Q4 on for about 1.5 seconds while C7 discharges through CR4 and R16.

CR5 prevents C7 from discharging through R18. Trim pots R1 and R2 calibrate the CW and CCW limits of the front panel dump pot to 5 cm and 95 cm respectively.

12.1.21 Pressure Transducer and PX1 and PX10 Amplifiers

The PLV-100 power board uses the PLV-102 pressure transducer. When it is operated on 5 volts, its output is proportional to 17.857 MV per cm of H_2O. The zero pressure output for this supply voltage is 0.857 volts. Thus, +100 cm H_2O is equal to 2.64 volts and -20 cm is equal to 0.5 volts. These voltages are not directly compatible with the PX1 and PX10 requirements of the PLV-100 logic board.

Zero pressure voltage for the PLV-100 “PX1” must be 1.35V. Sensitivity must be 60 MV per cm H_2O. In order to accomplish this, the output of transducer U4 is amplified by Op Amp U3 whose gain is calibrated by pot R22. Zero offset is set by pot R23 through voltage follower U7.

The PLV-100 “PX10” pressure measurement channel requires a gain of 3.57 over PX1. This is accomplished by amplifying the PX1 output of U3A (pin 1) with the “PX10” circuit of U3B (output pin 7). The PX1 and PX10 pressure signals go to the PLV-100 logic board through ribbon cable connector P5.

12.1.22 Precision 5 Volt Reference

U12, a precision 5 volt regulator, provides a stable and accurate 5 volts for the pressure transducer, electronic dump and the PX1 and PX10 amplifiers.

12.1.23 Relief Valve

The relief valve, operated by the microprocessor approximately once every minute, applies zero pressure to the pressure transducer U4, thus enabling dynamic recalibration of the pressure system. A logic high signal from the microprocessor on P3-7, turns on U13F which, in turn, activates the relief solenoid.

12.1.24 MOTOR DRIVE BRIDGE

The motor which operates the PLV-100 is a noninductive, bidirectional D.C. motor rated at 20 amperes, although average currents are limited to 5 amps to preserve motor life. The motor is driven from a power FET "H" bridge circuit, wherein, for the motor to drive, one upper FET and the opposite lower FET must be turned on simultaneously. When the motor is stopped, both lower FET's are turned on and both upper FET's off.

Three control lines from the microprocessor on the digital board are required to operate the bridge. /MOT IN and /MOT OUT are TTL control lines that determine motor movement and direction. Only one line may be low at a time; both lines high means that the motor is stopped. MOTPUL is a pulse width modulated (PWM) signal at a frequency of 20 KHz. This signal goes high every 50 microsecond; the longer it stays high, the greater the motor torque.

In this way, a very short positive pulse every 50 microsecond yields a very low motor torque, while a very short duration of low level signal produces a very high motor torque (a 0% duty cycle simply means that the motor will not turn, while a 100% duty cycle is not permitted by the hardware design).

12.1.25 MOTOR DRIVE LOGIC

U6 is a high voltage open collector hex inverter. /MOT IN and /MOT OUT are inverted by two sections in U6. This provides active high steering logic to the /MOTPUL signal through U5 NAND gates. The signal is then re-inverted to turn off the unused lower power FET in the "H" bridge (+12 volts gate to source turns the FET's on). The PWM signal MOTPUL, gated by either in or out direction signal, is re-inverted and used to power the corresponding upper FET in the bridge. Thus when /MOT IN is low, Q9 is turned off by inverter U6 pin 8, while Q11 remains on. U5 pin 4 is high, enabling motor pulses through U5 pin 6, inverted by U6 pin 4, turning on Q10. Plus voltage is then applied to the motor at P4 pin 6, and ground is provided at P4 pin 3.

If /MOT IN goes high and /MOT OUT low, Q11 and Q10 are turned off and Q9 and Q12 turned on. Plus voltage then appears at P4 pin 3 and ground at pin 6, reversing the direction of the motor. To provide the requisite +12 volts gate to source on the upper FETs, when the source of the on FET is already sitting at nearly +line voltage, blocking diodes CR25 and CR22 and bootstrap capacitors C33 and C31 are provided.

Each pulse of the 20 KHz PWM signal pumps a small charge into the bootstrap capacitor connected to the gate of the on upper FET, boosting the voltage at the node of the blocking diode and the 1K pullup resistor towards 27 volts. Diodes CR8 and CR9 limit the positive voltage to twice the +LINE voltage using the shared clamping zener diode Z1.

Capacitor C22, 10000µF, is an extremely low resistance capacitor, designed for delivering high peak surge currents. Its function across the 'H' bridge is to deliver most of the peak currents for each pulse of the 20 KHz PWM signal, thereby averaging the load current which must be delivered from the +13.8 volt line. The negative terminal of C22 is connected to ground through Q5 a BUZ11 FET. When power is first turned on, Q5 does not allow C22 to charge fully immediately, thereby greatly reducing the initial peak charging current to a safe level. R50 and C21 in the gate of Q5 provide the slow turn on time constant for Q5.

12.1.26 BOOTSTRAP CIRCUIT

The PWM drive signal to turn on the upper FETs is furnished by open collector driver U6. When the output of U6 is off, the gate of the respective FET is pulled high (and on) through the 1K resistors R55 or R59. The effective gate "on voltage", for example, is the voltage at the junction of CR25, R59 and C33. During the off period of the PWM signal, C33 is charged to +13.8 volts. When the FET turns on, its source rises toward +13.8 volts. The negative side of C33 is connected to the source. As the FET source rises, the effective gate voltage goes toward +27 volts, leaving a net gate to source bias of +12 volts and the FET stays fully on. Diodes CR25 and CR30 are back biased and not conducting during this period. The maximum voltage on the gates of the FETs is limited to +27 volts by CR8, CR9 and 27 volt zener diode Z1.

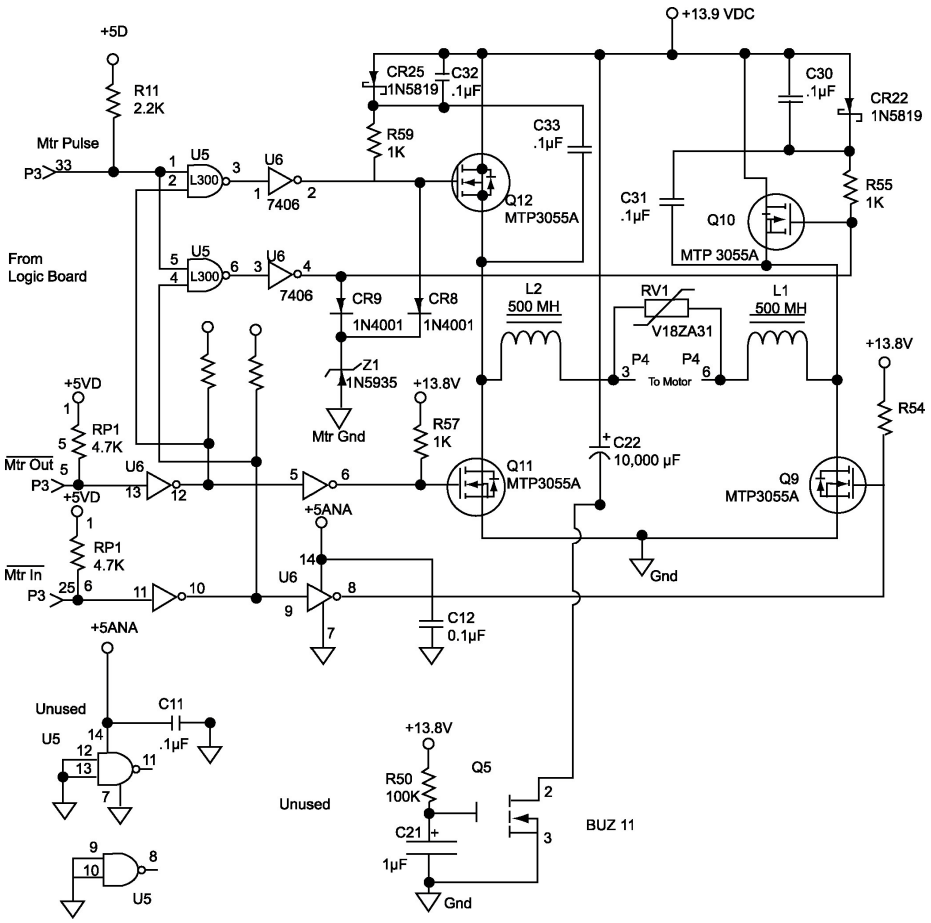

FIGURE 12-12 MOTOR DRIVE BRIDGE (POWER BOARD 35950)

12.2 DIGITAL BOARD THEORY OF OPERATION - OVERVIEW

The digital board implements within the PLV-100 a full microprocessor-based computer system. The computer accepts as input the setting of the front panel knobs and switches, executes a program resident in EPROM (Electrically Programmable Read Only Memory) within the machine, displays as output various front panel indicator lights and LCD digital displays, and controls all facets of the internal operation of the ventilator. In troubleshooting and analyzing the operation of the unit, it must be remembered that the front panel operator's controls do not directly affect the performance of the ventilator but only provide signals to be interpreted by the microprocessor.

The microprocessor used in the PLV-100 is an Intel 8085AH, U11, operating at 2.56 MHz. Program is contained in a 27128 EPROM, U29, while an Intel 8155H peripheral chip provides three parallel I/O ports, one used as TTL input and two as output, plus a 16-bit counter timer used for software synchronization, and 256 bytes of RAM (Random Access Memory) in which data variables can be stored. Hardware and software timing is controlled by a 5.12 MHz crystal controlled clock oscillator and a series of clock dividers which divide the master clock frequency in half sixteen times. Motor drive timing is controlled by an 8254, U23, which contains three independent counter timer circuits.

Fourteen analog voltages are read by the microprocessor using an ADC0808 analog to digital converter, U27, and a 4051B CMOS multiplexer chip, U19. A 4516B CMOS counter is used as a latch for the MUX's I/O address lines.

12.2.1 MEMORY ADDRESSING

The 8085 microprocessor uses a multiplexed address/data bus. The lower eight of 16 address lines are shared with the 8-bit data bus. During the first half of an instruction cycle, pins AD0 through AD7 contain address information. Near the end of this period, to allow settling time on the lines, the microprocessor asserts ALE, the Address Latch Enable signal. This signal is used to enable loading the address information into an 8-bit latch, retaining the lower addresses for the duration of the instruction cycle. Then, depending on the status of the WR* and RD* lines, either the processor or the addressed peripheral chip puts eight bits of data into AD0 through AD7. A8 through A15 retain valid address information throughout the instruction cycle.

A 74LS373 octal "D" latch, U17, is used to latch the lower address bus in the PLV-100. Address decoding is accomplished with a 74LS139 dual 2 to 4 decoder, U12. All I/O is memory mapped; the IO/M* line is not used. ROM is mapped into the lowest 16K of address space, occupying memory addresses 00 through 3FFF (hex). The 8155 is mapped into the next 16K, with RAM at address 4000 through 40FF hex.

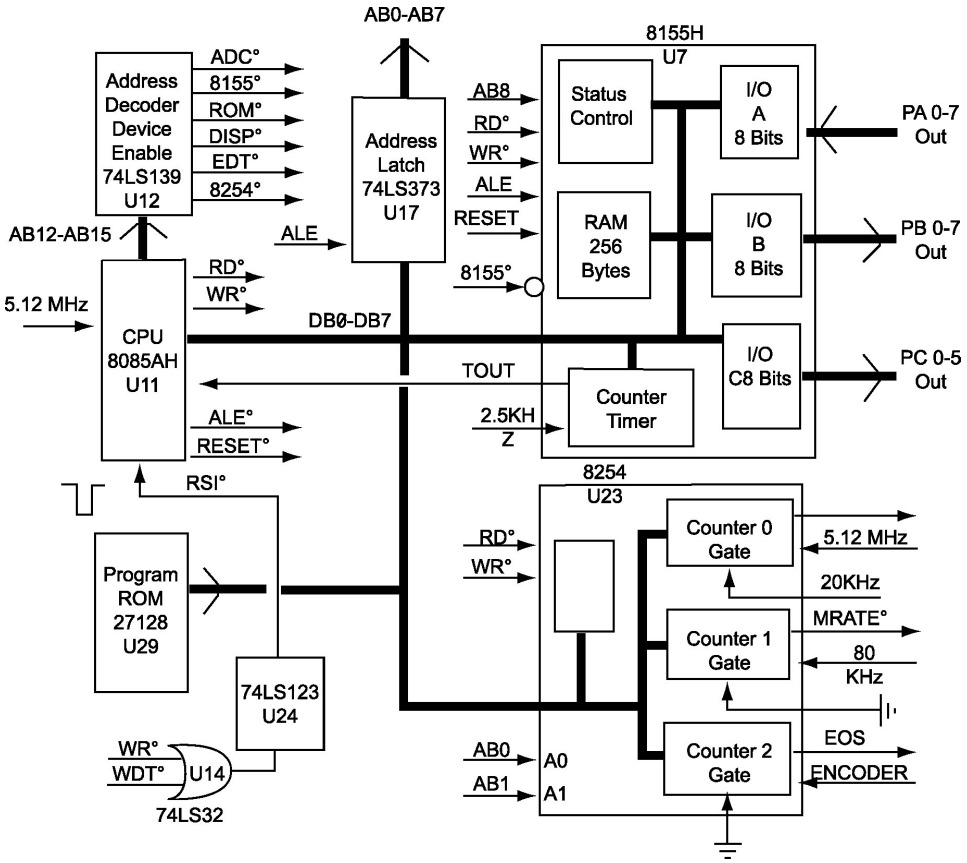

FIGURE 12-13 MEMORY ADDRESSING

The uppermost 16K of memory space (address C000 through FFFF hex) is further subdivided, using the second 2 to 4 decoder in U12. Address lines AB12 and AB13 are decoded to make four segments of 4K each. Addresses starting at C000 are dedicated for the counter/timer chip U23; D000 resets the watchdog timer,

which if not reset regularly will cause a total system reset. Addresses E000 through E004 access LCD front panel digital displays. These functions will be explained in subsequent sections.

12.2.2 PARALLEL I/O PORTS

The 8155 peripheral chip, U7, is mapped into the second block of 16K (addresses 4000 through 7FFF), with RAM at address 4000 through 40FF hex. Because AB8 is wired into the IO/M* input on U7, the I/O ports, normally accessed at the same address but with IO/M* high (asserting an I/O operation), appear starting at address 6000 hex.

Port A on U7 is defined as eight bits of parallel TTL level input signals. The first bit (designated Bit 0) detects an End of Conversion (EOC) signal from the ADC chip; the next two bits read the three position mode switch. Bits 3 and 4 read the battery test switch, 5 the inner limit switch, 6 the outer limit, and Bit 7 reads the ZERO signal from the zero board (ZERO also produces an interrupt into the microprocessor at Restart 5.5).

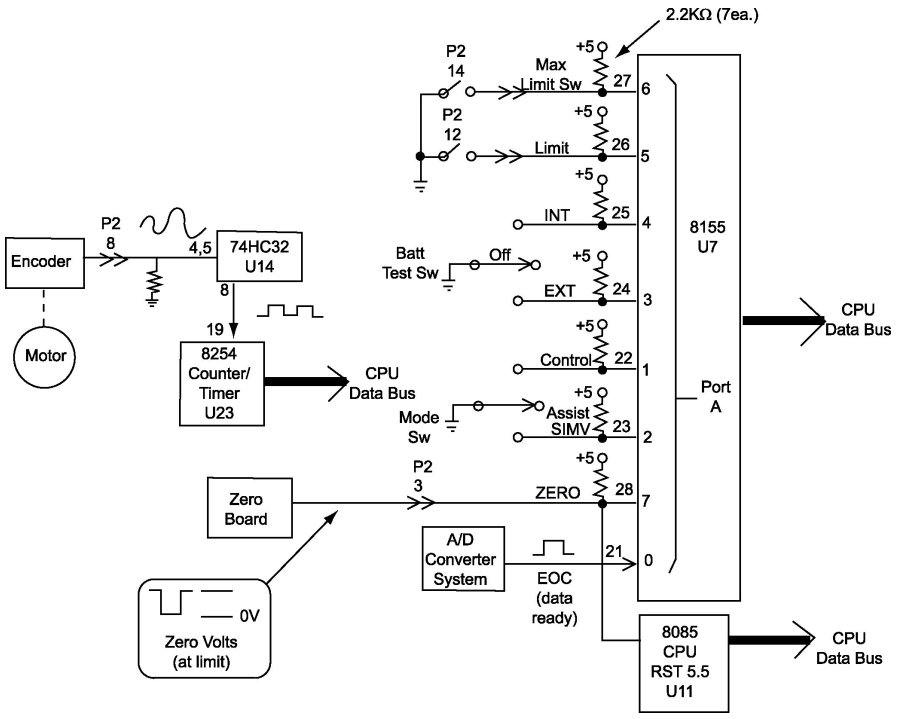

FIGURE 12-14 PARALLEL I/O PORTS: INPUT PORTS

Ports B and C are defined as 14, one bit output ports. All of these outputs are buffered by 7407 open collector hex drivers. The six bits of Port C and Bit O of Port B drive control signals through the 50-pin ribbon cable back to the power board. PC0 and 1 generate MOT OUT and MOT IN, respectively; PC2 the RELIEF signal which operates the Relief valve on the back panel, explained later. PC3 is reserved for a purge signal. PC4 generates INT ON, which operates the relay to disconnect the internal battery during external battery operation, while PC5 controls the external battery charger with the CHARGE signal.

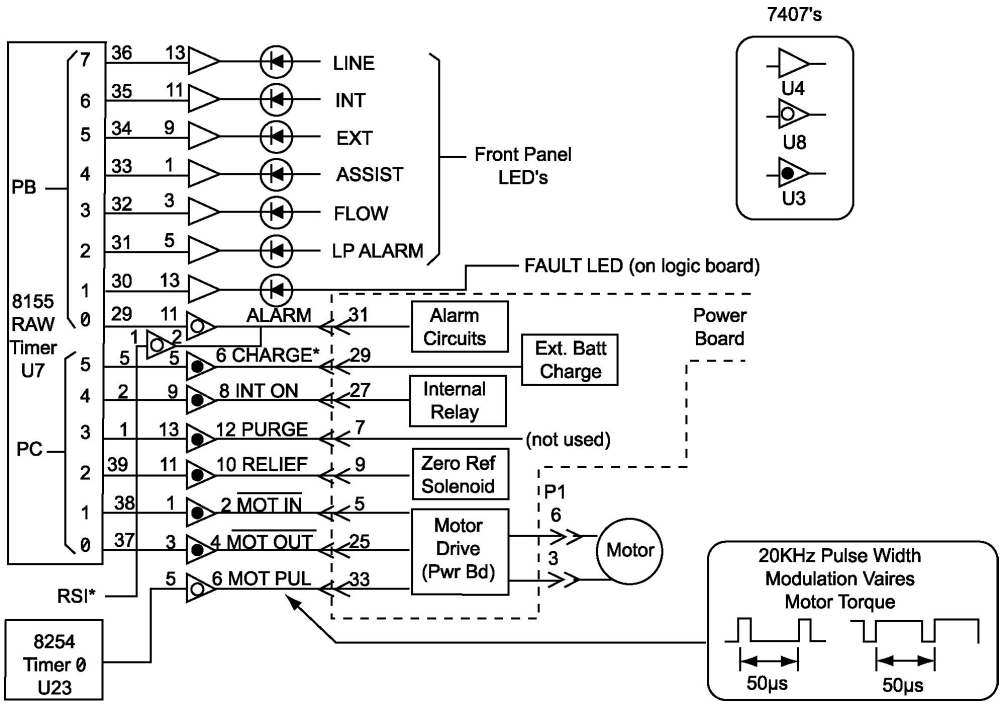

FIGURE 12-15 PARALLEL I/O PORTS: OUTPUT PORTS

PBO, whose output buffer is wired-OR with the RSI* signal, operates the alarm circuitry to produce an audible alarm under microprocessor control. PB1 lights the FAULT LED, located on the digital board, in the event of any microprocessor-detected operational faults. The remainder of Port B outputs operate the front panel indicator LEDs, Low Pressure Alarm, FLOW, ASSIST, EXT Battery, INT Battery, and 120V Line, for PB2 through 7 respectively.

12.2.3 ANALOG INPUTS

The third 16K of memory is allocated to the ADC chip U27 and it's multiplexer chip U19. Six lower address lines, AB0 through AB5, are used to distinguish the 14 multiplexed inputs. Seven of these inputs read by the microprocessor are potentiometers: VOLUME, RATE, FLOW, Sensitivity, and Low Pressure Alarm on the front panel, plus V TRIM and P TRIM trimmers on the digital board. These are read as straight ratiometric values; a reading of 0 to 5 volts on the pot wiper, corresponding to the knob setting on the front panel, is interpreted as an eight bit binary value in the range of 0 to 255 to the microprocessor.

Five analog inputs are critical system voltages, which the processor monitors for control and error detection purposes. The +Raw voltage, generated whenever the instrument is running on utility power, is divided by 5 using a network of 100 K ohm R-pack resistors to bring it below the 5 volt limit for the ADC input. Internal Battery, External Battery and the +Line are divided by three, while the +5 volt digital is divided by two before being read.

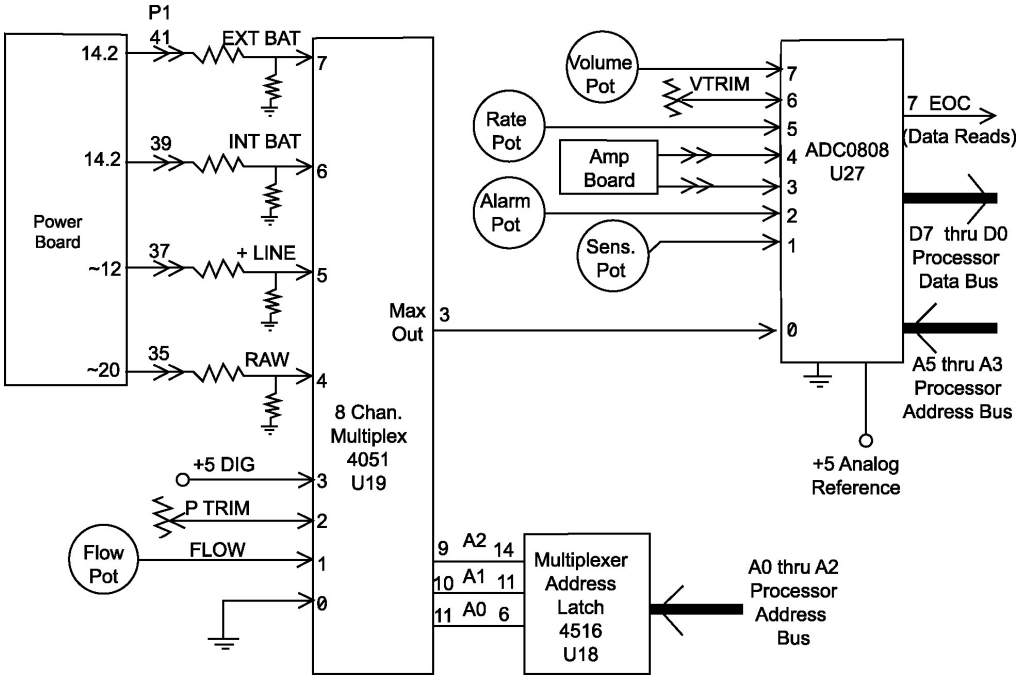

FIGURE 12-16 ANALOG INPUTS

All of these voltages are effectively compared to the +5V analog reference voltage, yielding a binary ratio within the range of 0 to 255 for use by the microprocessor. The remaining two inputs are similarly ratioed with the +5V analog, yielding the two pressure readings used by the instrument. P X 1 is a lower sensitivity measurement providing positive pressure readings used in the calculations for required motor torque. P X 10 is higher sensitivity measurement useful at negative system pressures to detect patient inspiratory effort.

P X 10 is also read by the microprocessor and tested to software defined limits during the startup procedure. If the initial reading is not within the requisite limits, the startup routine will repeat until an acceptable reading is obtained. (This condition can easily be simulated by disconnection the 14-pin ribbon cable to the amp board.) Once the ventilator has successfully started up, every minute the microprocessor rezeros the pressure reading by outputting a TTL signal called RELIEF (U7, PC2), which energizes the relief valve on the back panel. Ambient pressure is then applied to the pressure transducer on the Amp Board until a zero pressure reading is obtained. This zero value is stored in RAM, and is used to correct any drift or offset in subsequent pressure measurements.

12.2.4 ANALOG ADDRESS DECODING

The three address lines, AB3 through AB5, drive the decode inputs to the ADC chip, U27. Thus each multiplexed input to the ADC is enabled by a bank of eight sequential addresses; 8000 to 8007 hex enabling input 0, the MUX output, 8008 to 800F hex for the sensitivity pot on input 1, 8010 - 8017 for the low pressure alarm pot on 2, 8018 - 801F for the P X 10 input from the amp board on 3, 8020- 8027 for P X 1, 8028 - 802F for the RATE pot on input 5, 8030 - 8037 for V TRIM on 6, and addresses 8038 through 803F to read the setting of the VOLUME pot on input 7.

Inputs 1 through 7 each have a single analog channel brought into them, therefore each requires only one address. However, input 0 comes from the MUX U19, which has seven inputs of its own which require further decoding. This is done with the three lowest address lines, AB0 through AB2. These address lines are latched into U18, a 4516 CMOS parallel load chip by a write to the ADC; these address lines provide unique addresses for each MUX input. Address 8000 enables MUX input 0, which is not used. Address 8001 enables MUX

input1, which reads the FLOW pot; 8002 the P TRIM; 8003 reads the +5V digital supply voltage; address 8004 enables the input of +RAW voltage, 8005 the +LINE voltage; 8006 the external and 8007 the internal battery voltages. Any of these addresses simultaneously enables the ADC's input 0, as described above.

12.2.5 CLOCK SIGNALS AND TIMING

The master clock frequency of 5.12 MHz is produced by U31, a hybrid TTL level clock oscillator chip. This frequency is used as the master clock by the 8085 microprocessor chip, U11, and by the 8254 counter/timer chip U23 to clock the motor pulse timer. The 74LS163 counter chip U30 then divides this clock in half four times, producing a 2.56 MHz clock, available to the microprocessor at JP2 (although unused in the current product), and a 640 KHz clock for use by the 0808 ADC chip U27.

The lowest frequency thus obtained, 320 KHz, is then divided another 12 times by U28, a 4040 CMOS clock divider. U28 produces an 80 KHz clock which is used by U23 to produce a microprocessor interrupt, MRATE*, for recalculating motor torque parameters, and the 20 KHz clock to U23 to gate the PWM motor pulse signal. A 2.5 KHz clock, TIN, is used to clock the timer in the 8155 peripheral chip U7, which generates a software synchronizing signal using the microprocessor's TRAP input. Finally, U28's lowest clock frequency, at 78.125 Hz, is used to clock the liquid crystal displays.

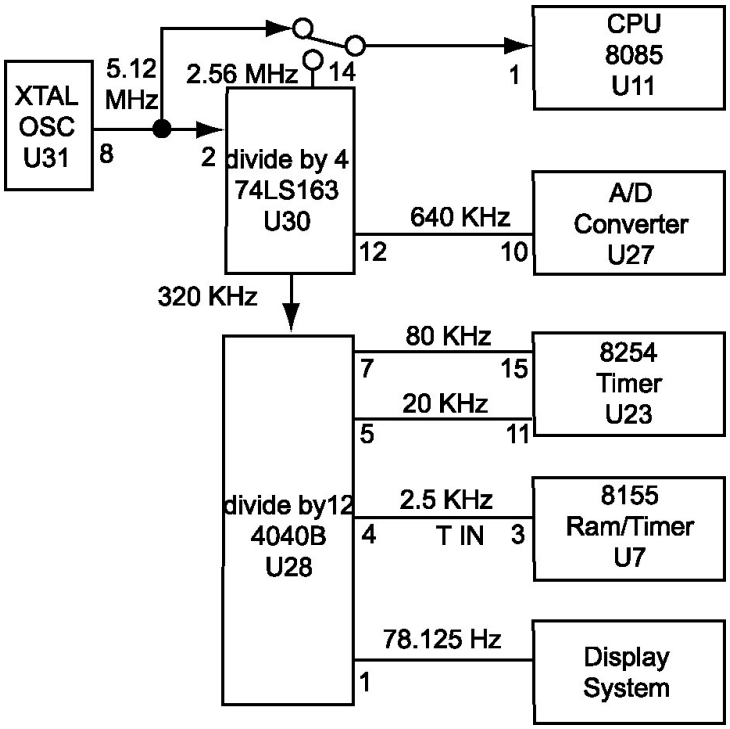

FIGURE 12-17 CLOCK SIGNALS AND TIMING

12.2.6 COUNTER/TIMER CHIP

The 8254 counter/timer chip, U23, contains three independent counter/timer circuits. Circuit 0 is used to generate the 20KHz Plus Width Modulated (PWM) motor pulse signal, which controls motor torque. This circuit is gated on every 50 microseconds by the 20 KHz clock signal. Before the next gate signal occurs, 256 clock pulses from the 5.12 MHz clock occur.

An eight bit number (0 to 225) is loaded into an internal register within the chip by the microprocessor; when this number of 5.12 MHz clock signals have been received, the output goes low, remaining low until the next 20 KHz gate signal resets it for the next cycle.

A higher number loaded into the counter register thus increases the time the pulse remains high, causing the motor to deliver more torque, while a smaller number reduces motor torque. The output, buffered by U8, drives through the 50-pin cable to the power board, where it is used to control the FET 'H' bridge motor driver.

Counter/timer circuit 1 is gated on all the time and clocked by the 80KHz signal from U28. Its output is MRATE* an interrupt to the processor whose frequency is programmed by the value loaded into the counter's timing register; it is used for software synchronization.

Circuit 2, similarly gated on all the time, is clocked by the pulses derived from the encoder on the motor shaft. These pulses measure motor rotation, and hence piston movement. The processor preloads into the counter's register the number of counts corresponding to the requested breath volume. When this volume is delivered, the encoder pulses have decremented this counter to zero. The processor is then notified by an interrupt.

12.2.7 WATCH DOG TIMER

When power is applied to the digital board, the Q* output on pin 4 of the 74LS123 dual one-shot, U24, is expected to power up in a logic low state, producing a startup reset pulse labelled RSI*. Besides going to the microprocessor, this signal is buffered by U8, and drives the ALARM* line to the power board low, causing a momentary beep of the alarm on startup.

Clearing the RSI* signal triggers the other half of the dual one-shot U24, which times out in approximately one second if not retriggered by a WDT* signal from the microprocessor. If time-out occurs, another RSI* reset signal is sent to the microprocessor, causing a complete reinitialization of the ventilator.

Ordinarily, the software program generates a WDT* signal several times a second to "notify" the watchdog that the program is executing properly. Should the program for any reason become lost and fail to retrigger the watchdog, a system restart is insured within one second.

12.2.8 ENCODER PULSES AND MOTOR POSITIONING

Mounted on the end of the motor shaft is a wheel with 128 radial slots etched through it. These slots allow light from an infrared LED to strike a photosensitive transistor, causing it to conduct a current. This current returns through R21 on the digital board to ground. As the motor makes one full revolution, 128 pulses of current will develop 128 voltage spikes across R21, driving the inputs of U14, part of a quad 2 input OR gate.

Two sections of U14 are used to square up and buffer the encoder pulses, which are then counted as clock inputs to counter/timer chip U23. Thus a total count of encoder pulses is maintained independently in hardware, making available to the microprocessor the position of the piston to within 1/128 of a turn.

NOTE

Earlier production units use an eighteen segment encoder wheel. These units require a different EPROM, U29; consult the factory for the latest version number.

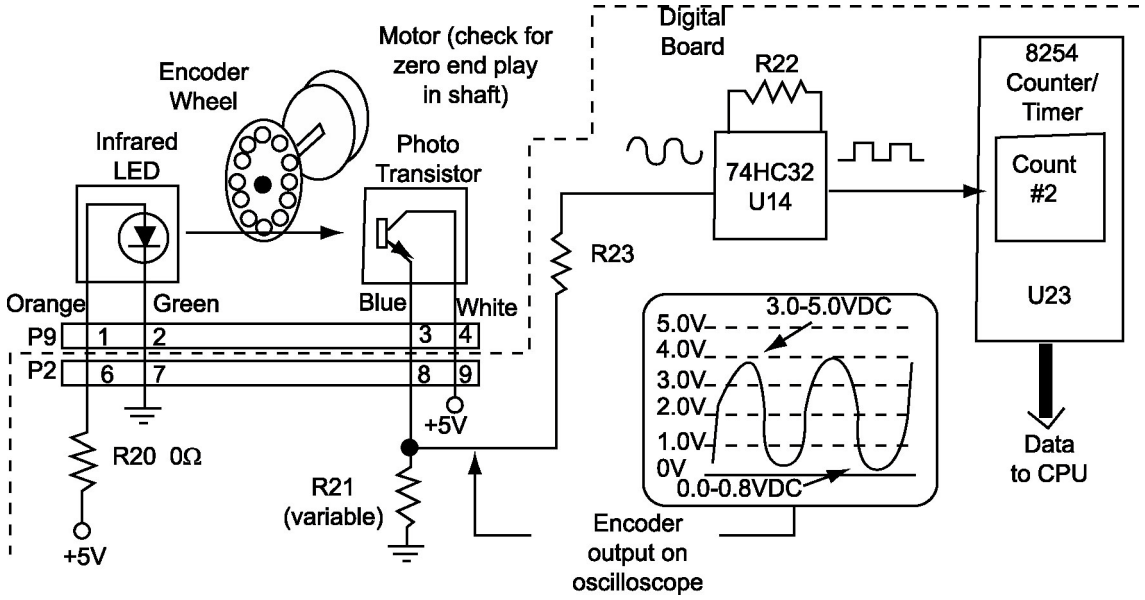

FIGURE 12-18 ENCODER PULSES AND MOTOR POSITIONING

12.2.9 LIQUID CRYSTAL DISPLAY SCHEMATIC AND DRIVER CHIP

Ten 4543 CMOS LCD driver chips drive the Liquid Crystal Displays on the PLV-100 front panel. Each chip has seven output drivers to operate the seven segments of a single digit.

Each of the four LCD modules has four digits, but only ten of the sixteen digits are microprocessor driven. The lower two digits are fully implemented on all displays, while the third lowest digit is used in the VOLUME and the FLOW windows. Each digit driver requires four data lines to encode ten decimal number values, so pairs of chips can be enabled with a single address; four bits of the 8-bit data bus going to each chip. Gated by decode line DSP* from the memory address decoder described above, a 74LS138 3 to 8 decoder chip, U20, decodes the three lowest address lines to create the necessary five active low enable signals. These outputs are enabled by the active low WRITE* line to generate LD0* through LD4*, corresponding to memory addresses E000 through E004 respectively.

LCD's require AC signals to maintain the display. A 78.125 Hz clock, LCDC, generated by the clock divider chip, is provided for this purpose. Buffered by U10, it is wired to all ten driver chips and used to blank all unused segments on the display modules; an inverted phase of this same pulse drives on the middle decimal point in the VOLUME display and the digit 1, the colon, and the right decimal point in the I:E RATIO display (this display reads 1:x.x, where the x's are numbers written by the microprocessor.)

The upper of three digits on the VOLUME (lower 4 data bits) and FLOW (upper 4 data bits) windows are loaded by LD0*, LD1* operates the lower digits of VOLUME (lowest digit on lower bits); LD2* writes to the FLOW window; LD3* the RATE; and LD4* the I:E RATIO.

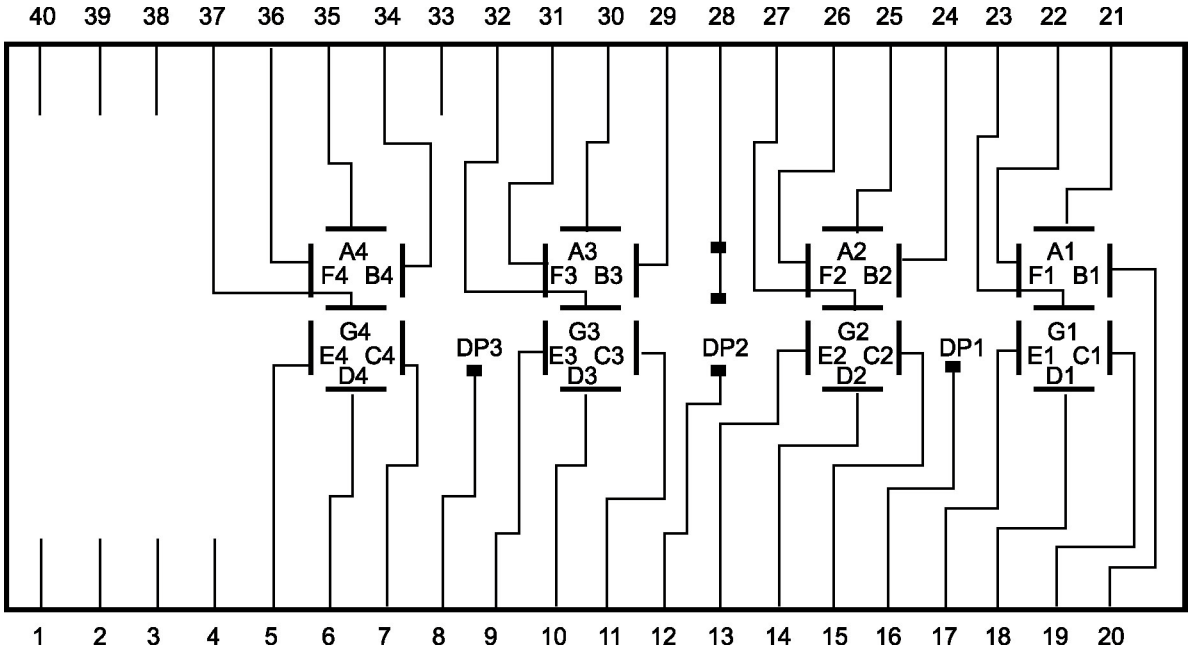

FIGURE 12-19 LIQUID CRYSTAL DISPLAY SCHEMATIC AND DRIVER CHIP

12.3 AMP AND ZERO BOARD THEORY OF OPERATION - AMP BOARD ASSEMBLY

The amp board assembly senses the pressure in the Peak Airway Pressure (PAP) line and converts it to an electrical signal that can be read by the microprocessor. This board is factory calibrated both for accuracy of pressure reading and for temperature stability. All components on the board affect the temperature stability, and replacement of any components will necessitate recalibration, and should be deferred to factory personnel.

Two DC output voltages are produced by the amp board for microprocessor sensing. PX 1, available on the AMP board at TP4, is used to read positive pressures in the range of 0 to 50 cm H_20. A higher gain output, PX 10, available at TP7, is used to read negative pressures in the range of 0 to -10 cm water for sensing inspiratory effort in SIMV and Assist Control modes. PX 10 is also read by the microprocessor during startup, and if out of limits (or if the amp board cable is disconnected), the ventilator will not start.

12.3.1 ZERO BOARD MODULE

The zero board module contains two independent circuits; the dump valve driver and the zero position detector.

12.3.1.1 DUMP VALVE DRIVER CIRCUIT

The dump valve driver is activated by a pressure switch located on the front panel adjustable airway pressure limit assembly. When Peak Airway Pressure (PAP) exceeds the level set by the pressure limit dial, the pressure switch closes, applying 13.8 V line voltages through R8 on the zero board to the gate of Q4, a power field effect transistor.

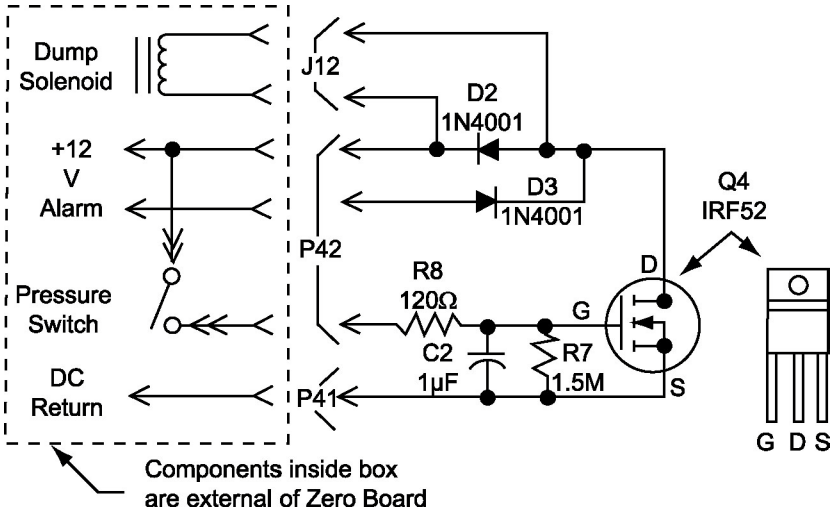

FIGURE 12-20 DUMP VALVE DRIVER CIRCUIT

This causes Q4 to turn on, energizing the dump valve solenoid, which vents the pressure from the PLV-100's cylinder.

While Q4 is held on by the pressure switch, capacitor C2 is charged to the line voltage. When the pressure switch opens, this charge holds Q4 on for another 1.5 seconds, until C2 discharges through R7. Thus complete venting of the cylinder pressure is assured before the next breath begins.

Diode D2 allows the rapid de-energizing of the dump solenoid at the end of the cycle, while protecting Q4 from destructive voltage spikes. While Q4 is on, diode D3 couples the low voltage at Q4's drain into the alarm circuit, causing an audible alarm whenever an overpressure condition occurs.

12.3.1.2 ZERO POSITION CIRCUIT

The zero position detector establishes a zero position at the maximum penetration of the piston into the cylinder, corresponding to the end of the inhalation stroke. A black wedge, mounted on the pressure side of the piston, passing through a slot in the bulkhead, interrupts a beam of infrared light (non-visible) emitted by photodiode D1 on the zero board.

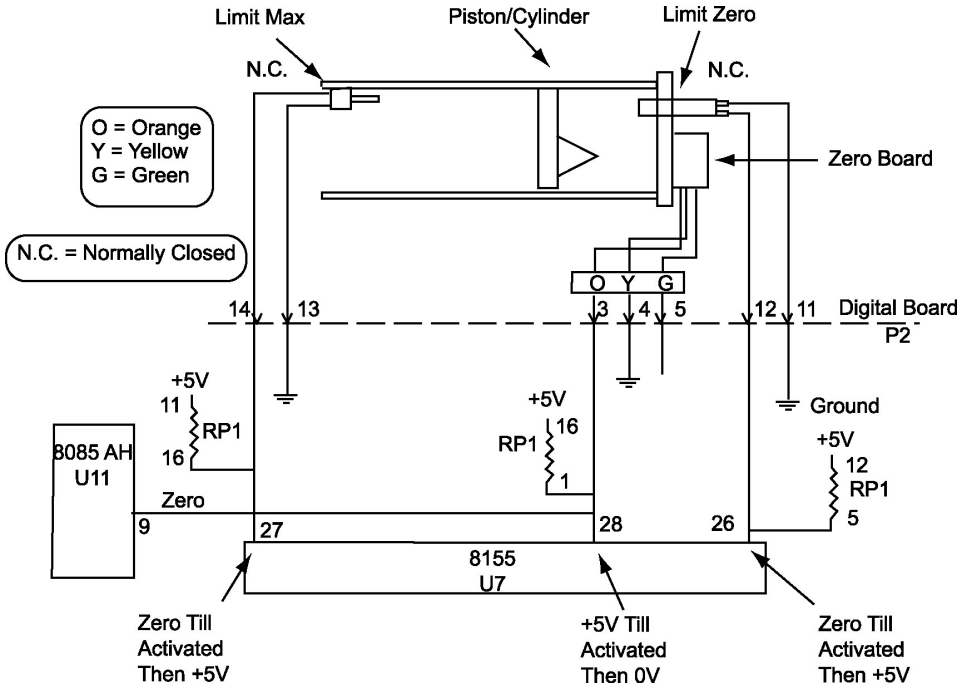

FIGURE 12-21 ZERO POSITION CIRCUIT

Loss of light to the detector phototransistor Q1 generates an electrical signal, which is amplified by transistors Q2 and Q3 and sent to the microprocessor on the digital board. The circuit below provides the zero position signal to the digital board as described above.

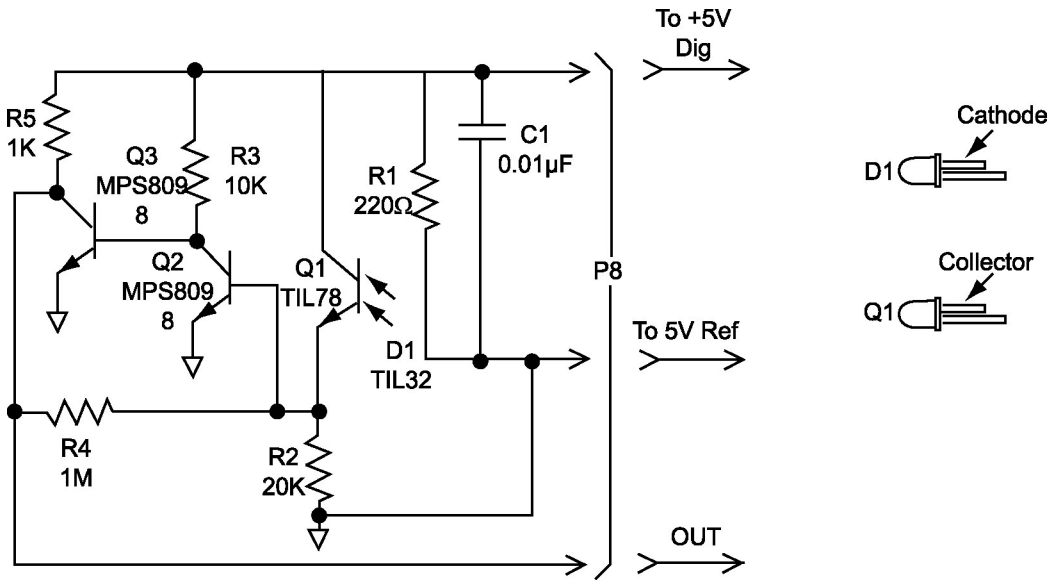

FIGURE 12-22 ZERO POSITION SIGNAL CIRCUIT

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CHAPTER 13 PARTS LIST

This section will provide a list of domestic and international parts available for sale. Some assemblies have certain raw parts available for sale.

NOTE

*Every part that is required to build assemblies are not available for sale. Part numbers with an * in front of them are the raw parts available for the bold typed assembly above them.*

Example:

F37089	***STRAP, RETAINING, OXYGEN***
37922	***OXYGEN VALVE ASSY, PLV-102***
** F38300*	** RP-TERMINAL, CRIMP, HIGH PRESSURE*
** F37077*	** VALVE,PROPORTIONAL CONTRL MDL*
F37934	***OXYGEN AIRWAY ASSEMBLY***
** 33440*	** LEAF, CHECK VALVE*
** 35016*	** BAFFLE,PATIENT TUBE*
** F38300*	** RP-TERMINAL, CRIMP, HIGH PRESSURE*
** 98608*	** TUBING,SIL RUB,3/16X5/16,BULK*

NOTE

For technical assistance or replacement part ordering information contact Respironics Worldwide Technical Service.

US and Canada
Phone: 1-800-345-6443
Fax: 1-888-886-0245

International
Phone: 001-724-834-4000
Fax: 001-724-387-5012

Email Address
service@respironics.com

Visit Respironics Home Page on the World Wide Web at:
www.respironics.com

13.0 ACCESSORIES

PART NUMBER	DESCRIPTION
35500	***MANUAL, CLINICAL, PLV-100***
35518	***INSTR, MINI-OP, PLV-100, 110V***
1005975	***RP-PLV SHIPPING CONTAINER***
35250	***KIT, CHARGER, ALARM BATT***
35308	***KIT, CAPACITOR AUXILIARY BD***
35665	***CABLE ASSY, BNC CONNECTOR***
35666	***ASSY, HARNESS, FLAT,14 COND, 3IN***
35667	***RAAS OPTION***
** 35664*	** CABLE ASSY, LIGHTED SWITCH*
** 35665*	** CABLE ASSY, BNC CONNECTOR*
35682	***ASSY, SLIDE, VENT***
** 35117*	** FLAP, VENT PLV CPT*
** 35123*	** SLIDE, VENT*
35870	***ASSY,VENT BODY***
** 35187*	** ELBOW, 1/2 X 90 DEG CPT*
33325	***FOOT,RUBBER,3/4 DIA X 7/16***
35317	***CORD,AC,PLV***
35681	***BALL CHAIN,3.75,CONN,NCKL PLD***
97057	***SCREW,CRPHMS,6-32X3/4,LT PATCH***
97058	***SCREW,CRPHMS-6-32X5/8,LT PATCH***
98035	***ENVELOPE,FUSE,PLV***
98402	***LABEL, ELECTRICAL SAFETY CHECK***
98802	***SCREW,CRPHMS,8-32X1/2,PACHLOC***
98804	***SCREW,CRPHMS,6-32X1/4,PACHLOC***
98807	***SCREW,CRPHMS,6-32X3/8,PAC,SS***
F35934	***ASSY, FACEPLATE COVER***
** 33330*	** FOOT, RUBBER, 9/16DIA X 3/8*
** 35096*	** O-RING, KNOBS*
** 35285*	** STUD,FACEPLATE COVER CATCH*
** 35286*	** STNDF,3/8DIAX9/16LG,AL,BLK,ANO*
** 35287*	** CATCH,FACEPLATE COVER*
** 35328*	** STANDOFF,THRDED4-40X5/16X7/8L*
** 35393*	** COVER, FACEPLATE*
** 35428*	** INSTR, FACEPLATE COVER*
** 35470*	** SCREW,HINGE PIN,MODIFIED*
** 35473*	** HINGE, COVER, FACEPLATE*

PART NUMBER	DESCRIPTION
* 37167	* SCREW, PHMS 6-32 X 1/4IN SST
* 37178	* SCREW PHMS,4-40 X 3/8 SST
F35972	**ASSY, FACEPLATE COVER, MASKED**
* 33330	* FOOT, RUBBER, 9/16DIA X 3/8
* 35096	* O-RING, KNOBS
* 35285	* STUD,FACEPLATE COVER CATCH
* 35286	* STNDF,3/8DIAX9/16LG,AL,BLK,ANO
* 35287	* CATCH,FACEPLATE COVER
* 35328	* STANDOFF,THRDED4-40X5/16X7/8L
* 35393	* COVER, FACEPLATE
* 35428	* INSTR, FACEPLATE COVER
* 35470	* SCREW,HINGE PIN,MODIFIED
* 35473	* HINGE, COVER, FACEPLATE
* 37167	* SCREW, PHMS 6-32 X 1/4IN SST
* 37178	* SCREW PHMS,4-40 X 3/8 SST
37697	**CORD,POWER,RT.ANGLE,INTN'L**
33330	**FOOT, RUBBER, 9/16DIA X 3/8**
37250	**CORD,POWER - 2 WIRE JAPAN**
35502	**MANUAL,OPRTG,CE PLV100-FRENCH**
98880	**SCREW,SHCS,6-32X3/8,LIGHT PTCH**

13.1 TOP/BOTTOM/SIDE PANELS

PART NUMBER	DESCRIPTION
F35963	**RP-ASSY,PANEL,TOP**
* 35190	* PANEL,TOP,CPT
* 98626	* GASKET,CNDTV,1/4 X 8.5,P-TYPE
35189	**PANEL, SIDE CPT**
35430	**PANEL,BOTTOM,WITH SCREEN**
* 15270	* PLUG, SCREEN VENT
* 35191	* PANEL, BOTTOM CPT
* 98626	* GASKET,CNDTV,1/4 X 8.5,P-TYPE

13.2 FRONT

PART NUMBER	DESCRIPTION
35664	**CABLE ASSY, LIGHTED SWITCH**
* 37041	* SWITCH, PUSHBUTTON, PCB, 8652

PART NUMBER	DESCRIPTION
F1000711	***KIT, PLV ALARM REPLACEMENT***
** F35056*	** ALARM,CPT*
F35421	***EPROM,PROGRAMMED,40 BPM***
35933	***ASSY,COVER, DC***
35940	***ASSY,D.C. RECEPTACLE***
F35902	***RP-FRONT MOD ASSY-PLV 100***
F35935	***RP-FRONT MD ASSY,CE PLV100-SWD***
F35879	***RP-FRONT MOD ASSY,PLV-100-JPN***
F35714	***RP-FRONT MD ASSY,PLV 100 DANISH***
F35704	***RP-FRONT MD ASSY,PLV 100,ENG-CE***
F35719	***RP-FRONT MD ASSY,PLV100-FRENCH***
F35740	***RP-FRONT MOD,PLV100-ITALIAN***
F35943	***RP-FRONT MOD ASSY,PLV100-220V***
F35691	***RP-FR PNL ASSY,PLV100-DOM***
F35151	***RP-FRONT MOD,230V SPANISH CE***
35984	***ASSY,FCPLT,MECH/ELEC DUMP,FLD***
35985	***ASSY,FCPLT,SNGL TURN DUMP,FLD***
**********	***AVAILABLE BOARD COMPONENTS***
** C02120*	** FITTING,PRESSURE,10-32 X 1/8ID*
** C06685*	** TUBING,PVC,1/8IN ID,BULK,UM=FT*
** 06686*	** TUBING,PVC,3/16IN ID,BULK,UM=FT*
** 21120*	** OUTLET, EXHAUST VALVE*
** 21125*	** OUTLET, NEBULIZER*
** 33440*	** LEAF, CHECK VALVE*
** 35012*	** GAUGE, -10 TO +100*
** 35016*	** BAFFLE,PATIENT TUBE*
** 35037*	** LENS, AMBER T-1 3/4*
** 35038*	** LENS, GREEN T-1 3/4*
** 35039*	** LENS, CLEAR T-1 3/4*
** 35040*	** LENS, RED T-1*
** 35041*	** LENS, GREEN T-1*
** 35063*	** KNOB, POINTER, SET SCREW, 1/8IN*
** 35064*	** KNOB,SKIRTED,SET SCREW,1/8IN*
** 35066*	** KNOB, FLOW & BPM & VOLUME*
** 35067*	** KNOB, SKIRTED, SET SCREW, 1/4IN*
** 35070*	** CKT BRKR, 2A,250V,PANEL*
** 35071*	** CKT BRKR, 5A,250V,PANEL*
** 35088*	** SWITCH, ROCKER, POWER, PLV*

PART NUMBER	DESCRIPTION
* 35089	* SWITCH,ROCKER,1808.0302
* 35096	* O-RING, KNOBS
* 35155	* RETAINING RING
* 35169	* COVER, SWITCH PROTECTIVE
* 35231	* SCREEN, ALARM
* 35414	* NUT,3/8-32,HEX,NYLON,BLACK
* 35455	* CAP, VINYL,PATIENT OUTLET
* 35664	* CABLE ASSY, LIGHTED SWITCH
* 35683	* ELBOW,PATIENT,E-DUMP
* F35691	* RP-FR PNL ASSY,PLV100-DOM
* F35835	* ASSY,DIG BRD,NEW OPTO
* 35933	* ASSY,COVER, DC
* 35940	* ASSY,D.C. RECEPTACLE
* 37026	* TIE ROD, PLV - FRONT, UPPER
* 37100	* TIE ROD, PLV - FRONT, LOWER
* 37134	* OUTLET, SNAP LOCK
* 37989	* ASSY,ELECT DUMP POT,PLV
* 98880	* SCREW,SHCS,6-32X3/8,LIGHT PTCH
* 35054	* BUSHING, FACEPLATE
* 35216	* PANEL, FRONT, 40 BPM
* 35394	* CKT BREAKR, 1.20A,25OV,PANEL
* F35836	* ASSY,DIG BRD,INTN'L OPTO
* 37301	* OUTLET,I.S.O.
* 35664	* CABLE ASSY, LIGHTED SWITCH
* 38115	* LENS,AMBER,T1,HLMP 1440
* 98845	* SCREW,CRPHMS,8-32X3/8,PACH,SS
35916	**ASSY,DIGITAL BOARD, PLV-100**
**********	* SEE LIST OF AVAILABLE BOARD COMPONENTS
F35835	**ASSY,DIG BRD,NEW OPTO**
**********	* SEE LIST OF AVAILABLE BOARD COMPONENTS
F35836	**ASSY,DIG BRD,INTN'L OPTO**
**********	* SEE LIST OF AVAILABLE BOARD COMPONENTS
F35730	**DGTL,PCB ASSY,GER-PWR SW PCB**
**********	* SEE LIST OF AVAILABLE BOARD COMPONENTS

13.3 BACK

PART NUMBER	DESCRIPTION
F35706	***RP-BACK MOD ASSY PLV100 ENGLISH***
F35919	***RP-BACK MOD ASSY,ENG,CE,3-WIRE***
**********	***AVAILABLE BACK MODULE PARTS***
** C01235*	** FUSE, SLO-BLO,5A*
** 35042*	** STAND-OFF, 4-40 X 1/2,AL*
** 35043*	** TIE ROD, PLV - REAR, UPPER*
** 35044*	** TIE ROD, PLV - REAR, LOWER*
** 35076*	** FILTER, REUSABLE, PLV*
** 35077*	** CAP,FILTER*
** 35126*	** HOUSING, FILTER*
** 35129*	** SCREEN, FILTER*
** 35144*	** FUHLR, BASE ONLY,3AG,PANEL,12A*
** 35145*	** FUHLR, CARRIER ONLY, 3AG*
** 35192*	** PANEL, BACK, PLV-100 - 110V*
** 35195*	** WRAP, CORD*
** 35247*	** SPACER,CORD WRAP, BLACK*
** 35277*	** BATTERY,6V,2.5AH*
** 35366*	** ELBOW, NYLON MALE,(VENT)*
** 35368*	** LABEL,PREVENTIVE SERVICE*
** 35468*	** PLUG,NYLON,3/16*
** 35855*	** BNC CONNECTOR ASSY, PLV-100*
** 35918*	** RFI ASSY*
** 35938*	** SOLENOID ASSY, ZERO REF & HOSE*
** 39573*	** METER, HOUR*
** 35948*	** GROUNDING STRAP ASSY*
** 37975*	** PCB ASSY, HOUR METER, PLV-102*
** 98800*	** SCREW,CRPHMS,4-40X1/4,PACHLOC*
** 98808*	** SCREW,CRPHMS,6-32X1-1/8,PACHLC*
** 98813*	** SCREW,CRFHMS,6-32X3/8,PACHLOC*
** 35938*	** TUBING,PVC,1/8IN ID,BULK,UM=FT*
** 33790*	** CONN/M,TEE,1/8 ID TUBING*
** 35202*	** TUBING,PVC,3/32IN ID,BULK*
** 35203*	** REDUCER,TUBING 1/8 ID TO 3/32*
** 35207*	** SOLENOID,VALVE*
** 37723*	** CONN/M,TEE,NYLON,1/8X3/16X1/8*
** 98807*	** SCREW,CRPHMS,6-32X3/8,PAC,SS*

PART NUMBER	DESCRIPTION
* 35391	* FUSE, 5A, 250V, MICRO, T5A
* 35392	* FUHLR, CARRIER ONLY, MICRO
* 38122	* FUSEHOLDER, 6.3A, PNL, 250V
* 35858	* GROUND STRAP ASSY, GERMAN
* 35665	* CABLE ASSY, BNC CONNECTOR
35996	**KIT,PR METER TO HR METER RETROFIT,PLV**
* 35367	* LABEL,MOTOR REPLACEMENT
* 35368	* LABEL,PREVENTIVE SERVICE
* 35369	* LABEL,ALARM BATTERY CHANGE

13.4 LEFT

PART NUMBER	DESCRIPTION
35276	**TRANSFORMER,TOROID,PLV**
* 35417	* CAP, 12K UF, 35V, ELECTROLYTIC
* 35930	* BRIDGE RECTIFIER ASSY
* F98150	* RP-TRIM, B-SPLCE,22-18 AWG,1.0L
* 98806	* SCREW,CRPHMS,6-32X1/2,PACHLOC
35925	**PANEL ASSY,LEFT,PLV100**
* 35081	* PLATE,CASE,SIDE
F35738	**RP-LEFT MOD, PLV-100-W/CONN**
F35900	**RP-LFT MOD ASSY,PLV100-INTL**
* 35921	* TOROID ASSY, INTL
* 35925	* PANEL ASSY,LEFT,PLV100
* 98845	* SCREW,CRPHMS,8-32X3/8,PACH,SS
F35908	**TOROID ASSY, 110V**
35921	**TOROID ASSY, INTL**
* 35276	* TRANSFORMER,TOROID,PLV
* 35417	* CAP, 12K UF, 35V, ELECTROLYTIC
* 35930	* BRIDGE RECTIFIER ASSY
* 98806	* SCREW,CRPHMS,6-32X1/2,PACHLOC

13.5 RIGHT

PART NUMBER	DESCRIPTION
35922	***HARNESS ASSY, SOLENOID***
35926	***PANEL ASSY,RIGHT,PLV-100***
** 35081*	** PLATE,CASE,SIDE*
35233	***SPACER, POWER BOARD***
35926	***PANEL ASSY,RIGHT,PLV-100***
F35950	***ASSY,PWR BRD,PLV-100,NEW STYLE***
**********	** SEE LIST OF AVAILABLE BOARD COMPONENTS*
35997	***ASSY,CABLE FLAT,14COND,12.25IN L***
98845	***SCREW,CRPHMS,8-32X3/8,PACH,SS***
F35852	***ASSY,POWER BRD,PLV-100,GERMAN***
**********	** SEE LIST OF AVAILABLE BOARD COMPONENTS*

13.6 PISTON CYLINDER

PART NUMBER	DESCRIPTION
F35844	***OPTICAL SWITCH ASSY, FIELD USE***
** 98800*	** SCREW,CRPHMS,4-40X1/4,PACHLOC*
35904	***ASSY,AMP BOARD PLV-100***
** 35115*	** SENSOR,PRESSURE,MPX10-DP*
** F39443*	** RP-IC/L, OP, AMP, DUAL*
F35906	***RP-ASSY,MOTOR***
** 35014*	** DISK & HUB ASSY,128 SEG-PLV100*
** 35034*	** GASKET, BULKHEAD*
** 35035*	** GASKET, MOTOR MOUNT*
** F35062*	** MOTOR,D.C.NCKL PLD ARMATURE*
** 35461*	** COUPLER, STAINLESS*
** F35844*	** OPTICAL SWITCH ASSY, FIELD USE*
** 98800*	** SCREW,CRPHMS,4-40X1/4,PACHLOC*
C02120	***FITTING,PRESSURE,10-32 X 1/8ID***
35018	***SWITCH, PUSHBUTTON, 8712***
35019	***BULKHEAD, CYLINDER - PLV-100***
35248	***GASKET,SENSOR,ZERO BOARD***
35314	***PAD,BULKHEAD -PLV-100***
F35923	***ASSY,ZERO BOARD,PLV-100,E-DUMP***
98807	***SCREW,CRPHMS,6-32X3/8,PAC,SS***
35085	***MOUNT, HINGE***

PART NUMBER	DESCRIPTION
35128	***SWITCH, MICRO, B2500211***
35222	***CONN/E, FEM, 14 PIN RIBBON***
35011	***HINGE, ROTATION***
35053	***RING, PISTON***
35058	***RING, HOLD DOWN***
35142	***PIN, INDEX ZERO***
35194	***LABEL, SOFTWARE***
35271	***CLAMP, FLAT CABLE***
35307	***LABEL, STATIC CAUTION 2 X 5/8***
35485	***PISTON/CYLINDER***
35920	***ASSY,PSTN/CYL,PLV-100FIELD USE***
** 35053*	** RING, PISTON*
** 35058*	** RING, HOLD DOWN*
** 35194*	** LABEL, SOFTWARE*
** 35271*	** CLAMP, FLAT CABLE*
** 35307*	** LABEL, STATIC CAUTION 2 X 5/8*
** 35367*	** LABEL,MOTOR REPLACEMENT*
** 35369*	** LABEL,ALARM BATTERY CHANGE*
** 35485*	** PISTON/CYLINDER*
** 98803*	** SCREW,CRPHMS,6-32X3/4,PAC,SS*
** 98806*	** SCREW,CRPHMS,6-32X1/2,PACHLOC*
** 98807*	** SCREW,CRPHMS,6-32X3/8,PAC,SS*
F35923	***ASSY,ZERO BOARD,PLV-100,E-DUMP***
** 35171*	** LED, INFRARED - 940NM*
** 35173*	** TRANSISTOR,PHOTO - TI*
** 39004*	** RES, 220. OHM, 1/4W, 5%, CF*
** 39040*	** XSTR, NPN, MPS8098, TO226AA*
33440	***LEAF, CHECK VALVE***
35016	***BAFFLE,PATIENT TUBE***
35020	***BRACE, CROSS***
35154	***GASKET, CYLINDER***
35272	***ELBOW,INLET***
35293	***RING, CLAMP***
35327	***STANDOFF, HINGE MOUNT***
F35830	***DUMP VALVE,ASSY***
F35951	***ASSY,RELIEF VALVE***
F35952	***BALLSCREW-S/L BLK ASSY, FIELD***
35937	***ZERO BOARD ASSY, PLV-100***

PART NUMBER	DESCRIPTION
* 35171	* LED, INFRARED - 940NM
* 35173	* TRANSISTOR,PHOTO - TI
F35951	***ASSY,RELIEF VALVE***
* 35429	* VALVE, RELIEF, MODIFIED
F35952	***BALLSCREW-S/L BLK ASSY, FIELD***
* 35036	* SEAL,GREASE,BALLSCREW
* 35415	* TURCITE NUT,FOLLOWER
* 35465	* SEAL, SPRING
F35958	***30-DUMP POT ASSY-ELECTRONIC***
35907	***ASSY,BULKHEAD***

13.7 MISCELLANEOUS

PART NUMBER	DESCRIPTION
35726	***KIT,RETRO,FACEPLATE COVER CTCH***
* 35285	* STUD,FACEPLATE COVER CATCH
* 35286	* STNDF,3/8DIAX9/16LG,AL,BLK,ANO
* 35287	* CATCH,FACEPLATE COVER
* 35393	* COVER, FACEPLATE
* 35428	* INSTR, FACEPLATE COVER
* 37167	* SCREW, PHMS 6-32 X 1/4IN SST
35910	***DC HARNESS ASSY, PLV-100***
33523	***PIN,ROLL,1/16DIA X 1/2L,SST***
35033	***NUT, 1/4-28, ROUND, SST***
35911	***ASSY,CABLE, FLAT***
* 35222	* CONN/E, FEM, 14 PIN RIBBON
F35956	***ASSY,SWITCH,FIELD USE***
* 35128	* SWITCH, MICRO, B2500211
F35957	***ASSY, SPRING ADJUSTOR***
35997	***ASSY,CABLE FLAT,14COND,12.25IN L***
* 35222	* CONN/E, FEM, 14 PIN RIBBON

13.8 AVAILABLE BOARD COMPONENTS

PART NUMBER	DESCRIPTION
F37118	IC/L, ADC0808, A TO D CONVERT
F39857	INVERTER,BACKLIGHT
F37146	POT, 5K OHM, 0.5W, 10%, PCB
F39858	RP-BACKLIGHT,EL
F39375	RP-CAP, 0.02 UF, 50V, FLAT, CERAMIC
F39373	RP-CAP, 0.03 IF.50V,FLAT, CERAMIC
F39372	RP-CAP, 0.03 UF, 50V, FLAT, CERAMIC
F39370	RP-CAP, 0.1 UF, 50V, CERAMIC
F39508	RP-CAP,.047UF,50V,DIP
F39051	RP-CAP,0.1UF,50V,DIP
F39564	RP-CAP,1 F,5.5V
F39369	RP-CAP,10UF,25V,TANTALUM
F39052	RP-CAP,22 UF,35V,TANTALUM
F39689	RP-CAP,22UF,35V,20%,TANT,RADIAL
F38002	RP-CONN/E,MALE,9 PIN D TYPE
F38298	RP-COVER,SWITCH,PLV-100,LOGIC BD
F37050	RP-DIODE, MBR2045CT, 20A, 45V
F35024	RP-DISPLAY,LCD
F39954	RP-DISPLAY,LCD,TRANSMISSIVE
F38248	RP-DRIVER,STEPPER MOTOR,GS-D200S
F37114	RP-IC/D, 16L8, PROGRAMMED PAL
F37115	RP-IC/D, 16R4, PROGRAMMED PAL
F39115	RP-IC/D, 2K RAM TIMER
F39122	RP-IC/D, 74LS123, DUAL ONE SHOT
F39485	RP-IC/D, HLCD-0438A, LCD DRIVER
F39131	RP-IC/D, MC14543B, LCD DRIVER
F39132	RP-IC/D, OSC, CLOCK, 5.12MHZ
F39486	RP-IC/D, SRAM, 2KX8, CMOS
F39059	RP-IC/D,7406,HEX INV,BUFFER
F39127	RP-IC/D,74HCT4040,12 BIT COUNTER
F39058	RP-IC/D,74LS00N,INPT QUAD NAND
F39114	RP-IC/D,8085AH,8 BIT CPU
F39482	RP-IC/D,HCT4020,14 STAGE COUNTER
F39484	RP-IC/D,LM1489,RS-232 DRIVER
F37066	RP-IC/D,P8085AH-2,MICROPROCESS
F39480	RP-IC/D,P8256AH,MUART

PART NUMBER	DESCRIPTION
F39476	RP-IC/D,V6366C-J,LCD CONTROLLER
F39483	RP-IC/D,X24C44,NOVRAM
F39057	RP-IC/L, 2003A, DARLINGTON ARRAY
F39118	RP-IC/L, ADC0808, A TO D CONVERT
F39443	RP-IC/L, OP, AMP, DUAL
F37067	RP-IC/L, P82C54, TIMER
F39565	RP-IC/L, VOLT REG, 5V, TO-220
F35104	RP-IC/L, VOLT REG, 5V, TO-3
F39443	RP-IC/L, OP, AMP, DUAL
F39056	RP-IC/L,15V,100MA,REGULATOR
F39542	RP-IC/L,LM339*N,COMPARATOR
F35102	RP-IC/L,LM350K,VOLT.REG.
F39129	RP-IC/L,MC14051B,8-CH MULTIPLEXER
F39427	RP-IC/L,MC33172P,DUAL OP-AMP
F35109	RP-IDCTR, 500 UH, POWER CHOKE
F38123	RP-JUMPER,PIN,0.025 SQUARE BULK
F35027	RP-LED, GREEN, T1 3/4,HLMP-3950
F35030	RP-LED, RED, TI, HLMP-1340
F39736	RP-OSC,CRYSTAL,16MHZ
F35069	RP-PAD,INSULATOR TO-3,2 PIN
F39133	RP-POT, 100K OHM, 0.5%W, 10%,PCB
F35083	RP-POT, 100K OHM, 1W, 10%, PCB
F39560	RP-POT, 10K OHM, 0.5W, 1%, TRMR
F35228	RP-POT, 10K OHM, 0.5W, 10%
F39145	RP-POT, 1K OHM, 0.5W, 10%, PCB
F39146	RP-POT, 5K OHM, 0.5W, 10%, PCB
F37122	RP-POT,10K,PANEL MOUNT
F35106	RP-RELAY, BATTERY
F39621	RP-RELAY,PCB,12VDC,SPDT
F39138	RP-RES, 0.10 KOHM, 7W, 1%, WW
F39323	RP-RES, 127. KOHM, 1/8W, 1%, MF
F39139	RP-RES, 56.0 OHM, 1/4W, 5%, MF
F39049	RP-RPAK, 100K OHM, 0.25W, 2%
F39048	RP-RPAK,2.2K OHM, 0.25W, 2%
F39820	RP-SWITCH,DPDT,W/O LEVER ACTUATOR
F37037	RP-TRANSDUCER, PRESSURE
F39787	RP-TRANSDUCER,PRESSURE,5V
F39147	RP-VARISTOR,V18ZA3,39V,4500A,10WV

PART NUMBER	DESCRIPTION
F39112	*RP-XSTR, PNP, 2N2907, TO206AA*
F35105	*RP-XSTR, PNP, 8A, DARLINGTON*
F37051	*RP-XSTR,FET,MTP3O55,TO22O*
F39416	*RP-XSTR,HEXFET,MTP1ON1OE,TO22OAB*
F39111	*RP-XSTR,NPN,2N2222,TO-18*
F39495	*RP-ZENER, 1N5908, 5W, 6V*
F38332	*TERM,FEM,22-18 AWG,.250X.032*
F35101	*XSTR,HEXFET,IRF130,TO-204AA*
39119	*IC/D, 74LS02, 2 INPUT QUAD*
39120	*IC/D,7407,HEX BUFFER*
35017	*SWITCH, ROTARY, 1836-103-CP*
35029	*LED, YELLOW, T1 3/4*
35031	*LED,GREEN,T1 HLMP1540*
35090	*SOCKET, SIP, 20 PIN*
39004	*RES, 220. OHM, 1/4W, 5%, CF*
39126	*IC/D,74LS373,OCTAL D-TYPE*
37038	*PAD,ISOLATION,TO-220*
39500	*IC/L,5V, REFERENCE,REF-02*
39574	*XSTR, FET, BUZ11, TO-220*

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CHAPTER 14 QA FINAL INSPECTION FORMS AND PROCEDURES

NOTE
N/A any entries that are not applicable.

Unit Serial Number:		*Date:*	

RT-200A (or equivalent):		*Electrical Safety Inspector S/N:*	
Multimeter S/N:		*Stop Watch S/N:*	
Low Voltage Test Box S/N:			

1.0 Documentation Audit					
1.0 Documentation and Serial Number	*PASS*	*FAIL*	*1.2 Run-in Time*	*PASS*	*FAIL*
2.0 Exterior inspection					
2.1 Exterior Surface	*PASS*	*FAIL*	*2.2 Knob Set Screw*	*PASS*	*FAIL*
2.3 15 Sec Delay	*PASS*	*FAIL*	*2.4 Mode Knob*	*PASS*	*FAIL*
2.5 Front Panel Nuts	*PASS*	*FAIL*	*2.6 Gauge Lens and LCD's*	*PASS*	*FAIL*
2.7 On/Off Switch	*PASS*	*FAIL*	*2.8 Sensor Vent*	*PASS*	*FAIL*
2.9 Prevent Service Labels	*PASS*	*FAIL*	*2.10 Hr. Meter and Cord Wrap Feet*	*PASS*	*FAIL*
2.11 Back Panel Filters	*PASS*	*FAIL*	*2.12 Back Panel Tightness*	*PASS*	*FAIL*
2.13 MFG. Plate	*PASS*	*FAIL*	*2.14 Top and Bottom Panels*	*PASS*	*FAIL*
2.15 Side Panels	*PASS*	*FAIL*	*2.16 Red Dump Valve LED (International Only)*	*PASS*	*FAIL*
2.17 Power Cord	*PASS*	*FAIL*			

3.0 Internal Inspection					
3.1 *S/N on Chassis*	*PASS*	*FAIL*	*3.2* *Internal Batteries*	*PASS*	*FAIL*
3.3 *Labels*	*PASS*	*FAIL*	*3.4* *Flat Cable Connectors*	*PASS*	*FAIL*
3.5 *Tubing, Hoses, and Cables*	*PASS*	*FAIL*	*3.6* *Circuit Boards*	*PASS*	*FAIL*
3.7 *Interior Assemblies*	*PASS*	*FAIL*	*3.8* *Motor Opto Switch*	*PASS*	*FAIL*
4.0 Electrical Safety Tests					
4.1 *Resistance (.01 Ohm Max.)*		*Ohms*	*4.2* *Leakage (100 µ A Max.)*		*µ A*
4.3 *Electrical Safety Sticker*	*PASS*	*FAIL*	*4.4* *High Pot Test (International Only)*	*PASS*	*FAIL*
5.0 Diagnostic Check					
5.1 *Startup Alarm*	*PASS*	*FAIL*	*5.2* *I:E Ratio LCD Display*	*PASS*	*FAIL*
5.3 *Diagnostic and Alarm Check*	*PASS*	*FAIL*	*5.4* *No repeat self-diagnostic*	*PASS*	*FAIL*
6.0 Pressure Relief Operation					
6.1 *Pressure Relief 105-115 cmH_2O*		*cmH_2O*	*6.2* *Remove Berg Jumper*	*PASS*	*FAIL*
7.0 Patient Airway Pressure Limit Check					
7.1 *High Pressure Limit* *85-105 cmH_2O*		*cmH_2O*	*7.2* *Low Pressure Limit* *0-10 cmH_2O*		*cmH_2O*
7.3 *48-52 cmH_2O on Unit Gauge and RT-200A (or equivalent)*		*cmH_2O*	*7.4* *Not Autocycling, No alarms, And Assist/Spontaneous LED Off*	*PASS*	*FAIL*
7.5 *Pressure Loss (Should <6 cmH_2O within 30 seconds)*		*cmH_2O*			
8.0 Low Pressure Alarm					
8.1 *Audible Alarm*	*PASS*	*FAIL*	*8.2* *LED Goes out at 18-22 cmH_2O*	*PASS*	*FAIL*
9.0 Assist Control Check					

9.1 *Unit Not Autocycling*	*PASS*	*FAIL*	*9.2* *Assist/Spontaneous LED 2 to 4 cmH_2O*	*PASS*	*FAIL*
9.3 *Assist/Spontaneous LED -.5 to -1 cmH_2O*	*PASS*	*FAIL*	*9.4* *Assist/Spontaneous LED -6 to -10 cmH_2O*	*PASS*	*FAIL*
9.5 *Unit Not Autocycling*	*PASS*	*FAIL*	*9.6* *BPM rate 11 to 13 BPM*	*PASS*	*FAIL*
10.0 SIMV Mode Check					
10.1 *BPM rate 11 to 13 BPM*	*PASS*	*FAIL*	*10.2* *Unit Not Autocycling*	*PASS*	*FAIL*
11.0 Breath Rate					
11.1 *38 to 42 BPM*	*BPM*		*11.2* *18 to 22 BPM*	*BPM*	
12.0 I:E Ratio Check (International Units Only)					
12.1 *Syringe is disconnected*	*PASS*	*FAIL*	*12.2* • *Unit display 1:1.5 to 1:1.6* • *Measuring Device display 1-1.5 to 1-2.1*	*I:E*	
12.3 • *Unit display 1:4.1 to 1:4.2* • *Measuring Device display 1-4.0 to 1-5.2*	*I:E*		*12.4* • *Unit display 1:5.8 to 1:5.9* • *Measuring Device display 1-5.6 to 1-7.3*	*I:E*	
13.0 Tidal Volume Check					
13.1 *0.03 to 0.07 Liters*	*Liters*		*13.2* *0.72 to 0.88 Liters*	*Liters*	
13.3 *2.46 to 3.02 Liters*	*Liters*		*13.4* *No Alarm at 2.80 Liters Vol.*	*PASS*	*FAIL*
13.5 *Audible Alarm at 2.99 Liters Vol.*	*PASS*	*FAIL*			
14.0 Flow Check					
14.1 *108 to 132 LPM*	*LPM*		*14.2* *36 to 44 LPM*	*LPM*	
14.3 *5 to 20 LPM*	*LPM*				
15.0 Power Sources Check					

15.1 *50.5 K to 51.5 K Ohms RASS I*		*K Ohms*	*15.2* *DC Circuit Breaker Alarm*	*PASS*	*FAIL*
00.0 to 01.0 Ohms RASS III		*Ohms*	*15.4* *Internal LED extinguishes/ External LED illuminates/ Alarm*	*PASS*	*FAIL*
Infinite RASS III		*Infinite*	*15.6* *Reverse Polarity Alarm*		*VDC*
Dutch Configuration		*Ohms*	*15.8* *TP4: 13.90 to 14.30 VDC*		*VDC*
15.3 *Alarm/Switch to Internal Battery/ Internal battery LED illuminates*	*PASS*	*FAIL*	*15.10* *Battery Volt. +/- 2 VDC*		*VDC*
15.5 *Low DC Voltage Alarm*		*VDC*	*15.12* *Chassis Resistance*		*Ohms*
15.7 *TP1: 13.90 to 14.30 VDC*		*VDC*			
15.9 *Difference 1.3 VDC Max*		*VDC*			
15.11 *1.0 V Max to Chassis*		*VDC*			
16.0 Shipping Configuration					
16.1 *Adjust Unit Settings*	*PASS*	*FAIL*	*16.2* *Electrical Safety Sticker and QA Accepted Sticker*	*PASS*	*FAIL*
16.3 *Back Panel Fuse in Envelope*	*PASS*	*FAIL*	*16.4* *Mini-Op Instruction Card*	*PASS*	*FAIL*
16.5 *Clear Faceplate*	*PASS*	*FAIL*			
Release					

Check Form (Leave this section blank if no discrepancy is observed)
A new inspection form and complete unit inspection must be performed following any observed discrepancies.
*Section #:*_____ *Step #:*_____

*Observed By Date:*_____

Accepted and released for distribution by Respironics.			
Inspected By		*Date*	

14.0 QA Final Inspection Procedure - PLV-100

14.0.1 Equipment Required

- RT-200A Timeter Calibration Analyzer (or equivalent measuring device)
- Reverse Polarity Cable (90-027)
- Low Voltage Power Supply
- Stop Watch (98235)
- Test Circuit
- 60cc Syringe
- Multimeter or equivalent
- 1 Liter Test Lung (C06657)
- Berg Jumper (35312)
- 24” x 3/16” ID Tubing (C06686)
- 1 Meg. Shunt (98265)

NOTE

See Section 2.1 for a detailed procedure for using the TSI Certifier to perform the QA Final Test.

14.0.2 Procedure

1.0 Documentation Audit

- Review each document for accuracy and completeness.
- Applicable lot codes that are visible must match between the unit and the traveler on modules, assemblies, boards, and critical components.
- The unit serial number must match all applicable documentation and the serial number plate on the back panel.

1.1 Applicable Documentation

- Applicable Returned Goods Documentation.

1.2 Run-in Time

- 96 hours Newly Manufactured
- 96 hours Remanufactured
- 96 hours Ballscrew replacement
- 24 hours Receiving PC board/Electo-mechanical/Harness repair
- 24 hours ECO change
- 12 hours Preventative Service/Preventative Maintenance

2.0 External Inspection

2.1 External Surface

- Must be free of scratches, marks, dents, or damage of any kind.

2.2 Knob Set Screws

- All must be tight on the stems.

2.3 15 Second Delay

- Yellow - International/European
- Green - Domestic

2.4 Mode Change Knob

- Must be tight on the stem.

2.5 Front Panel Nuts

- Must be tight on the fuse breakers, and the alarm silence LED.

2.6 Gauge Lens and LCD Windows

- Must be clean, Gauge must be zeroed. Any protective plastic must be removed.

2.7 ON/OFF Switch

- Must have a cover over it.

2.8 Sensor Vent

- Must be tight on the back panel.

2.9 Preventative Service Label

- Must be under air vent. (If applicable)

2.10 Hr. Meter & Cord Wrap Feet

- Must be tight on the back panel.

2.11 Filters

- Must be clean.

2.12 BNC Connector, Fuse Holders, Cord Wind, Filter Covers, and RFI. (If applicable)

- Must be tight and fit securely on the back panel.

2.13 MFG. Plate

- (As applicable) Must show Model, S/N, Catalog #, Voltage and Hz.

2.14 Top and Bottom Panels

- Must fit without bowing.

2.15 Side Panels

- Must be screwed onto the unit without denting, bowing, or buckling the screw holes.

2.16 Dump Valve LED

- Must have Red LED (International units only).

2.17 Power Cord

- Must be correct power cord for the model unit.

3.0 INTERNAL INSPECTION

- Remove top and bottom panels. (As applicable)

3.1 S/N

- S/N will either be stamped on the top of the Bulkhead or handwritten on the cylinder.
- Must match the S/N on the MFG. Plate and all applicable documentation.

3.2 Internal Batteries

- Must be tie wrapped securely to the back panel.

3.3 Labels

- The static warning label, copyright label, and motor replacement label must be installed on the piston cylinder.

3.4 Flat Cable Connectors

- All must be properly connected.

3.5 Internal Tubing, Hoses, Wires, Cables, PT. Outlet, and Elbows

- All must be clean and neatly routed.

3.6 Circuit Boards

- Must be clean, securely mounted in the unit, and the lot code must match the applicable documentation.

3.7 Internal Assemblies

- All must be clean, no cracking.

3.8 Motor Opto-Switch

- Must be clear of wires and tubing.

4.0 Electrical Safety Tests

- As applicable, an inspector may elect to use Leakage, Resistance, and High Pot readings taken during the manufacturing or service process by Manufacturing or Service Personnel to use on Final Inspection Form, section 4.0.
- Record the Ground Resistance (Protective Earth Resistance from ground to chassis) test results in step 4.1
- Record the Ground Leakage (Leakage Current from Mains to Protective Earth) test results for all three wire units in step 4.2.
- For two wire units, record the Ground Leakage (Leakage Current Mains to Enclosure) test results taken in step 4.2.
- The electrical safety sticker on all applicable European units must be round. (97977A)
- All two wire units have two prong plugs and will not require a ground resistance test. N/A step 4.1.
- On all International/European units, the line voltage green LED must be lit when the unit is plugged into its power source with the unit off.

4.1 Ground Resistance

- Must be no more than 0.1 Ohm.

4.2 Ground Leakage

- Must be no more than 100 micro amps.

4.3 Electrical Safety Sticker

- European - 97077A
- International - 98402A

4.4 High Pot Test (International Only)

- Verify the high pot test results from mfg.

5.0 Diagnostic Test

- During initial start-up the units LCD's will not display any set number pattern.
- Connect unit to applicable power source.

5.1 Turn Unit On

- An audible alarm must sound.

5.2 I:E Ratio

- LCD windows will display 8's for approximately one (1) second. I:E ratio will display 1:8.8 for approximately one (1) second.

5.3 Diagnostic and Alarm Check

- The units LED's will turn on and off in the following order: Flow, assist spontaneous, 15 second delay, external battery, and internal battery, and VAC.
- An audible alarm must sound.
- The unit will begin to cycle.

- Turn unit off.
- Attach a 60cc syringe to the pap outlet on the unit.
- Push in plunger until at least cm H_2O shows on the unit gauge.

5.4 Turn Unit On

- Unit must not repeat self-diagnostic check.
- Turn unit off.
- Remove syringe.

6.0 Pressure Relief Operation

- Disconnect the dump valve to test the pressure relief valve. If you have a new style dump valve, use a berg jumper.
- Disconnect the white three pin Molex connector (bottom of power board) or connect a berg jumper to J1 (top of power board).
- Set up circuit and measuring device to measure peak pressure.
- Disconnect and completely occlude the Gauge inlet tubing during testing of the pressure relief valve to prevent damage to the gauge.
- Turn unit on.
- Set Mode to Control, Volume to 0.70, BPM to 7, LPM 10 to 40, Sensitivity fully clockwise, LPA to 2 and Airway pressure limit fully clockwise.
- Occlude the end of the test circuit with the restrictor.
- Do not exceed 40 LPM flow to achieve test results.

6.1 Suitable Measuring Device

- Must show a reading of 105 to 115 cmH_20
- Repeat as necessary to obtain test results.
- Turn unit off.

6.2 Jumper

- Reconnect the white molex connector or remove the berg jumper from pin J1.

7.0 Patient Airway Pressure Limit Check

- Turn unit on.
- Set Volume to 0.50 and BPM to 10.
- Do not exceed 40 LPM flow to achieve test results.

- (As applicable) Continue to occlude the gauge inlet tubing.

7.1 Suitable Measuring Device

- Completely occlude the end of the restrictor.
- On European units the RED Dump Valve LED must light when the dump valve is activated.
- Must show a reading of 85 to 105 cm H_2O.
- Turn Airway Pressure Limit fully counter-clockwise.

7.2 Suitable Measuring Device

- Reconnect the Gauge Inlet Tubing onto the gauge.
- Remove the restrictor and attach the test lung.
- Must show a reading of 0 to 10 cm H_2O.

7.3 Unit Gauge and Suitable Measuring Device

- Turn Airway Pressure Limit clockwise to 50 cm H_2O.
- Must show dumping at 48 to 52 cm H_2O and audible alarm must sound.

NOTE

If the Alarm Silence button has been activated, the audible alarm will not sound until the Alarm Silence delay time has expired, or up to 30 seconds.

7.4 At Unit Settings

- Turn Airway Pressure Limit fully clockwise.
- Unit must not autocycle, No alarms, and Assist Spontaneous LED must be off.
- Turn unit OFF.
- Remove the airway pressure/pap line.
- Attach the 60cc syringe to the pap connector on the unit.
- Push in syringe plunger until at least 40 cm H_2O shows on the unit gauge. If the syringe has a shut off, close it. If it doesn't, pinch tubing shut with a pair of needle nose pliers to hold the 40 cm.
- Start Stopwatch.

7.5 Pressure Loss

- The unit gauge must not show a pressure loss of more than 6 cm H_2O within 30 seconds.
- Record any (applicable) pressure loss.

8.0 Low Pressure Alarm Check

- Confirm LPA is fully counterclockwise.
- Attach the 60cc syringe to pap outlet on the unit.
- Turn unit ON. Allow the unit to go through self-diagnostic check.
- Start a stopwatch.

8.1 Alarm Condition (audible)

- A steady audible alarm must sound within 30 seconds.
- Push in the syringe plunger until the alarm stops.
- Watch the gauge.

8.2 Alarm Stop

- Alarm must stop at 18 to 22 cm H_2O.
- Remove the 60cc syringe.
- Reattach the pap line on to the unit.

9.0 ASSIST CONTROL MODE CHECK

- Set Mode to Assist Control, Volume to 0.50, BPM to 10, LPM flow until I:E Ratio LCD shows 1:2.0, and LPA to 2 cm H_2O.
- Unit must autocycle at these settings.
- BPM Rate will increase.
- Remove the pap line and reattach the 60cc syringe.
- Push in syringe plunger until at least 4 cm H_2O shows on the unit gauge.

9.1 Unit not autocycling

- The unit must stop autocycle at these settings.
- Slowly pull out the syringe plunger until the low pressure alarm 15 second delay LED illuminates.

9.2 15 Second Delay LED

- Repeat this test as necessary to obtain test results.
- Turn Sensitivity knob counter-clockwise until it is just left of the zero setting.
- Adjust and repeat as necessary to obtain the following test results.
- Squeeze the test lung to simulate a breath.
- Watch the Assist/Spontaneous LED and units gauge.

9.3 Assist/Spontaneous LED

- Must light up at a -0.5 to -1 reading on unit gauge.
- The key words to this test are gently and adjust.
- To keep the LPA from sounding, pull the plunger out of the syringe to simulate an exhale.
- Turn Sensitivity counter-clockwise to -6 reading on unit.
- Gently inhale through the test circuit.
- Watch the Assist/Spontaneous LED and unit gauge.

9.4 New Style Front Panel

- Assist LED must light up at a minimum of -6 cm H_2O reading on the unit gauge.
- Turn sensitivity just to the left of the “0” (zero) setting.

9.5 Unit not Autocycling

- At these settings the unit must not autocycle.
- Change BPM to 5.
- Push in the plunger on the syringe and at the same time, start a stop watch.

- Repeat inhalation every 5 seconds for approximately 20 seconds.

9.6 BPM Rate

- Must show 11-13 BPM.

10.0 SIMV Mode Check

- Set Mode to SIMV, Volume to 0.50, BPM to 5 and LPM to 40 and I:E Ratio to 1:.
- Squeeze the test lung to simulate a breath, and at the same time start a stopwatch.
- Repeat inhalation every 5 seconds for approximately 20 seconds.

10.1 BPM Rate

- Must show 11-13 BPM.

10.2 Unit not Autocycling

- Unit must not autocycle at these settings.

11.0 Breath Rate

- Set Mode to Control, Volume to 0.50, BPM to 40, LPM set until I:E ratio LCD shows 1:2.0.
- As applicable, average the BPM rate.
- During this test it may be necessary to set the BPM to 10 for one or two (and re-zero as applicable) breaths before resetting the BPM back to 40 and continue testing.
- Set the circuit and measuring device to read breaths per minute (BPM) and remove the test lung

11.1 Suitable Measuring Device

- Must show a BPM rate of 38-42 within 30 seconds.
- Set BPM to 20.
- Set the I:E Ratio to 1:2.0.
- Average the BPM as applicable.

11.2 Suitable Measuring Device

- Must show a BPM rate of 18-22 within 30 seconds.

12.0 I:E Ratio Check (International Units Only)

- Set BPM to 40 and LPM to 80.
- During this test it may be necessary to set the BPM to 10 for one or two (and re-zero as applicable) breaths before resetting BPM back to 40 and continuing to test.

12.1 Syringe

- Disconnect syringe.

12.2 Unit I:E Ratio

- Unit must show 1:15.
- Measuring device must show 1-1.5 to 1-2.1.
- Change BPM to 20.

12.3 Unit I:E Ratio

- Unit must show 1:40.
- Measuring device must show 1-4.0 to 1-5.2.
- Change BPM to 15.

12.4 Unit I:E Ratio

- Unit must show 1:57.
- Measuring device must show 1-5.6 to 1-7.3.

13.0 TIDAL VOLUME CHECK

- Set Volume to 0.05, BPM to 10, and LPM to 10
- Set measuring device and circuit to measure volume.

13.1 Suitable Measuring Device

- Must show a volume between 0.03 to 0.07 within 30 seconds.
- Set Volume to 0.80 and LPM to 40.

13.2 Suitable Measuring Device

- Must show a volume between 0.72 to 0.88 within 30 seconds.
- Set Volume to 2.74 and LPM to 120.

13.3 Suitable Measuring Device

- Must show a volume between 2.46 to 3.02 within 30 seconds.
- Remove the PAP line from the front of the unit and attach the syringe.
- Push in the plunger until at least 4 cm H_2O shows on the unit gauge.
- Set Volume to 2.80.

13.4 PLV-100

- Unit must not alarm at a 2.80 Volume setting.
- Set Volume to 2.99.

13.5 PLV-100

- Unit must alarm when the piston hits the outer limit switch.

14.0 FLOW CHECK

- Set Volume to 2.75.
- Set up measuring device and circuit to measure peak flow.

14.1 Suitable Measuring Device

- Must show a flow between 108 to 132 within 30 seconds.
- Set Volume to 0.80 and LPM to 40.

14.2 Suitable Measuring Device

- Must show a flow between 36 to 44 within 30 seconds.
- Set Volume to 0.20 and LPM to 10.

14.3 Suitable Measuring Device

- Must show a flow between 5 to 20 within 30 seconds.

15.0 POWER SOURCES CHECK

- Set Volume to 1.00 and LPM to 45.
- Remove the 60cc syringe and reconnect the pap line to the unit.
- Attach the 1 (one) liter test lung.
- QC all units as R.A.A.S. 1 (unless otherwise noted).
- To test resistance set multimeter to 200K ohm range.

- Test resistance from the BNC center pin to the BNC housing, or use a banana jack connected to the BNC.

15.1 R.A.A.S.

- R.A.A.S. I - 50.5 to 51.5 K ohm's.
- R.A.A.S. II - 00.0 to 01.0. (N/A)
- R.A.A.S. III - INFINITE (N/A)
- Dutch configuration - INFINITE (N/A)
- Remove the multimeter from the BNC connector.

15.2 DC Circuit Breaker (5 Amp)

- Pull out the 5 amp circuit breaker.
- An Audible alarm must sound.
- Reset the circuit breaker.
- Unit should go through self-diagnostic test.

15.3 Internal Battery Test

- To switch to internal battery operation, unplug the unit from its power source, or pull out the AC Power Circuit Breaker.
- An audible alarm must sound.
- Unit must switch to Internal battery.
- Internal LED must light.

15.4 External Battery Test

- Set the power supply to 12VDC.
- Connect the reverse polarity cable to the units front panel DC receptacle. Make sure cable box switch is on normal.
- An audible alarm must sound.
- Unit must switch to external battery.
- External LED must light.

15.5 Low Voltage Alarm Test

- Set the multimeter to the 20VDC scale.
- Attach multimeter leads TP2 (ground), and TP5 (positive).
- Set BPM to 2.
- Once at the setting of 2 BPM, the unit may take a breath.
- Attach syringe and apply +4 cm H_2O to keep LPA from sounding.
- Reduce the low voltage power supply counter-clockwise to multimeter readings.
- 10.0 VDC - The low voltage alarm must not sound.
- 9.0 to 9.5 VDC - The low voltage alarm must begin to sound.
- 8.5 VDC - By 8.5 VDC, alarm must fully sound.
- 7.0 VDC - The unit must switch to internal battery operation within the 30 second time frame.
- Set the BPM to 10.

- Turn unit off.
- Adjust the low voltage power supply DC control to 12 VDC.
- Make sure reverse polarity cable is connected.

15.6 Reverse Polarity Test

- Flip the switch on the reverse polarity cable.
- An audible alarm must sound.
- Remove the reverse polarity cable from the unit.
- Reconnect unit to its AC power source or reset the AC Power circuit breaker.
- Remove the back fuse.
- Attach the positive lead to the multimeter to TP1.

15.7 Multimeter Reading

- Must be 13.90 VDC to 14.30 VDC.
- Attach the positive lead of the multimeter to TP4.

15.8 Multimeter Reading

- Must be 13.90 to 14.30 VDC
- Reinstall back panel fuse.
- Attach the positive lead of the multimeter to TP1.
- Observe the multimeter reading. (If need be, write it down.)
- Unplug the unit from it's applicable power source or pull out the 2 amp circuit breaker.
- Observe the multimeter reading after 15 seconds.

15.9 Difference Between Readings

- Difference between readings must be no more than 1.3 VDC.
- Set BPM to 2.
- Turn unit on.
- Allow the unit to go through its start up sequences.
- Depress the internal side of the battery check switch.
- Observe the voltage in the flow LCD.
- Observe the multimeter voltage.

15.10 Difference Between Readings

- Readings must be +/- 2 VDC of each other.
- Set BPM to 10.
- Reconnect unit to its power source or reset the AC Power circuit breaker.
- Turn the unit off.
- Add the 1 meg shunt for the following test only. (step 15.11)
- Attach the positive lead of the multimeter to the chassis.
- Turn the unit on.
- Observe the multimeter.

15.11 Max Voltage

- No more than 1 VDC.
- Turn unit off.
- Disconnect unit from it's AC power source.
- Remove the 1 meg shunt from the multimeter.
- Change multimeter to the 200K range to read resistance.

15.12 Multimeter Reading

- Must show an INFINITE reading.
- Remove multimeter from the unit.
- Write INFINITE on final test data sheet step 15.12 if unit passes this test.

16.0 SHIPPING CONFIGURATION

16.1 Settings

- Set Patient Airway Pressure Limit to 50 cm H_2O.
- Set LPA to 10.
- Remove test circuit # 1.
- (As applicable) Attach top and bottom panels and feet onto the bottom panel with screws.

16.2 Completed Electrical Safety Label and QA Accepted Sticker

- Attach both to the middle edge of the bottom panel.
- For Rental and Recertified units, leave back panel fuse in place for shipment.
- On all European units, the Electrical Safety Label will be round.

16.3 Back Panel Fuse Envelope

- Attach (as applicable) to a handle of the unit with a chain.
- Not Applicable to rental and/or recertified units.

16.4 Mini-Op Instruction Card

- As applicable for 35002 and 35009 only, attach to a handle of the unit with the back panel envelope.

16.5 Clear Faceplate

- As applicable for 35003, 35006, 35007, 35008, 35009, 35010, and 35800 only, attach to the front of the unit.

16.6 Power Cord

- Wrap the power cord on unit and if unit has a Hold Down Clamp, clamp and tighten the power cord.

14.1 USING THE TSI CERTIFIER TO QA PLVS

14.1.1 EQUIPMENT REQUIRED

- TSI High Flow Module with Oxygen Certifier (1012598)
- PLV Leak Restrictor Test Orifice (1016583)
- Silicone Tubing (1000825)
- O2 Enrichment Port (312710)

- Test Circuit - See Figure 2-1 through Figure 2-4 for assembly

14.1.2 PROCEDURE

14.1.2.1 TO MEASURE PEAK PRESSURES WITH THE TSI CERTIFIER

1. Set up the TSI as follows:
   - Bottom Line = Peak cmH_20
   - Display Units = ATP
   - Trigger = 1 LPM
2. Set up the CIRCUIT as depicted in Figure 2-1, using the PLV Leak Restrictor test orifice for testing.

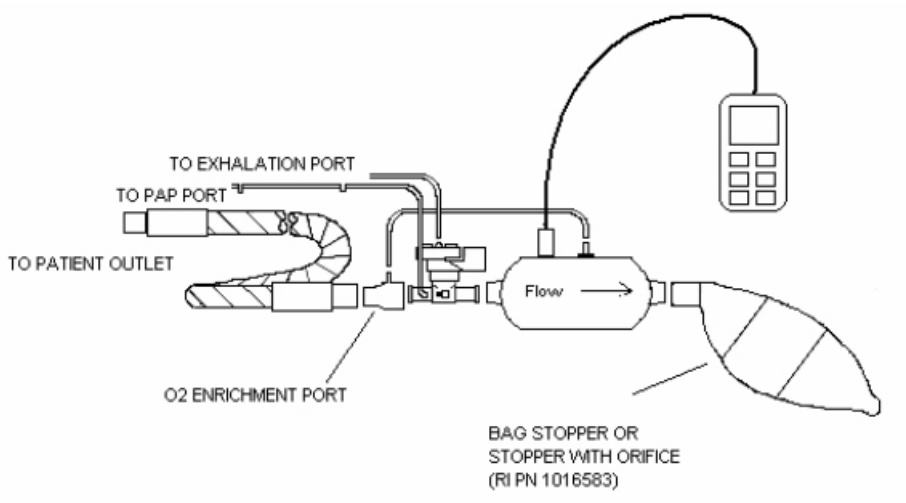

FIGURE 14-1

3. Allow the unit to deliver a few breaths before using the stopper. Record the readings on the appropriate forms.
4. When testing the pressure relief valve, the test orifice must be used. While testing the dump valve use the test lung, restricting it with your hands.

14.1.2.2 TO MEASURE VOLUME WITHOUT OXYGEN

1. Set up the TSI as follows:
   - Top Line = Tidal Volume
   - Display Units = ATP
   - Gas = Air
2. Set up the CIRCUT as shown in Figure 2-2

NOTE

If you want to read counted breaths, see the TSI Manual.

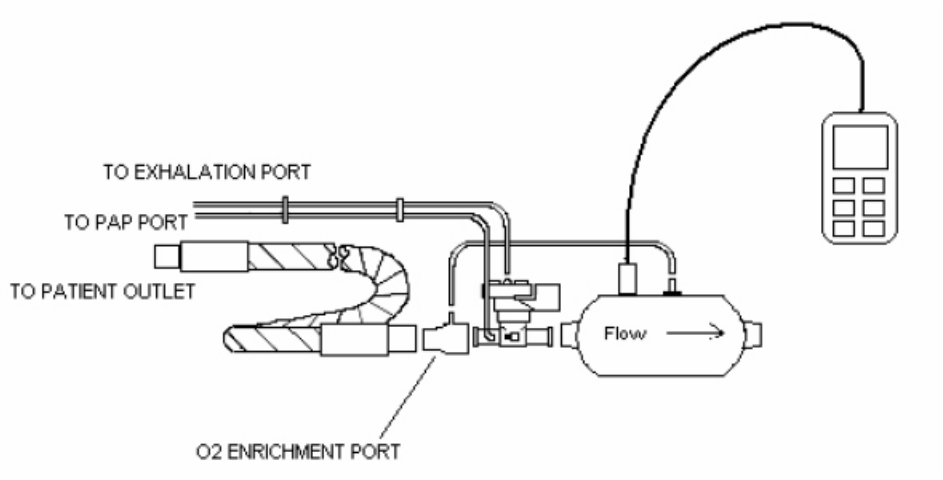

FIGURE 14-2

3. Allow the unit to deliver a few breaths before recording the results.

14.1.2.3 TO MEASURE VOLUME WITH OXYGEN

1. Set up the TSI as follows:
   - Top Line = Tidal Volume
   - Bottom Line = $\%O_2$
   - Trigger (Top Button Extended Hold) = 10 peak
   - Display Units = ATP
   - Gas = Air/O_2
2. Set up the CIRCUIT as shown in Figure 2-3.

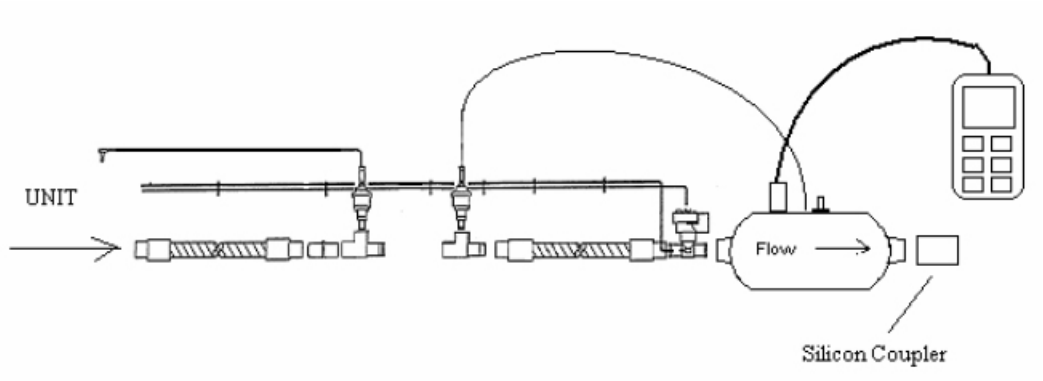

FIGURE 14-3

3. Allow the unit to deliver a few breaths to stabilize.

4. Record the Volume and Oxygen Percentage on the appropriate forms.

NOTE

The TSI Certifier takes the reading from its oxygen analyzer to compensate for the % of oxygen in use. There is no need to adjust to read at 30%, 50%, or 90% as long as the unit is set to read air and oxygen.

14.1.2.4 To Measure Peak Flow

1. Set up the TSI as follows:
   - Top Line = Peak LPM
   - Display Units = LPM
   - Trigger (Top Button Extended Hold) = 10 Peak
2. Connect the CIRCUIT as show in Figure 2-4. Plug Exhalation Port.

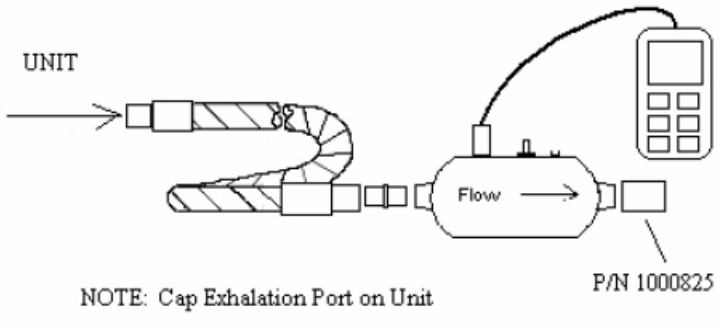

Figure 14-4

3. Allow the unit to deliver a few breaths before taking measurements.

14.1.2.5 To Measure I:E Ratio

1. Set up the TSI as follows:
   - Bottom Line = I:E
   - Trigger (Top Button Extended Hold) = 2 LPM
   - Display Units = ATP
   - Gas = Air/O_2
2. Set up the CIRCUIT as shown in Figure 2-4. Plug the Exhalation Port. Allow the unit to deliver a few breaths before recording I:E Ratio.

14.1.2.6 To Measure BPM

1. Set up the TSI as follows:
   - Bottom Line = BPM
   - Trigger (Top Button Extended Hold) = 2 LPM
   - Display Units = ATP

- Gas = Air

2. Set up the CIRCUIT as shown in Figure 2-4. Plug the Exhalation Port. Allow the unit to deliver a few breaths before recording.

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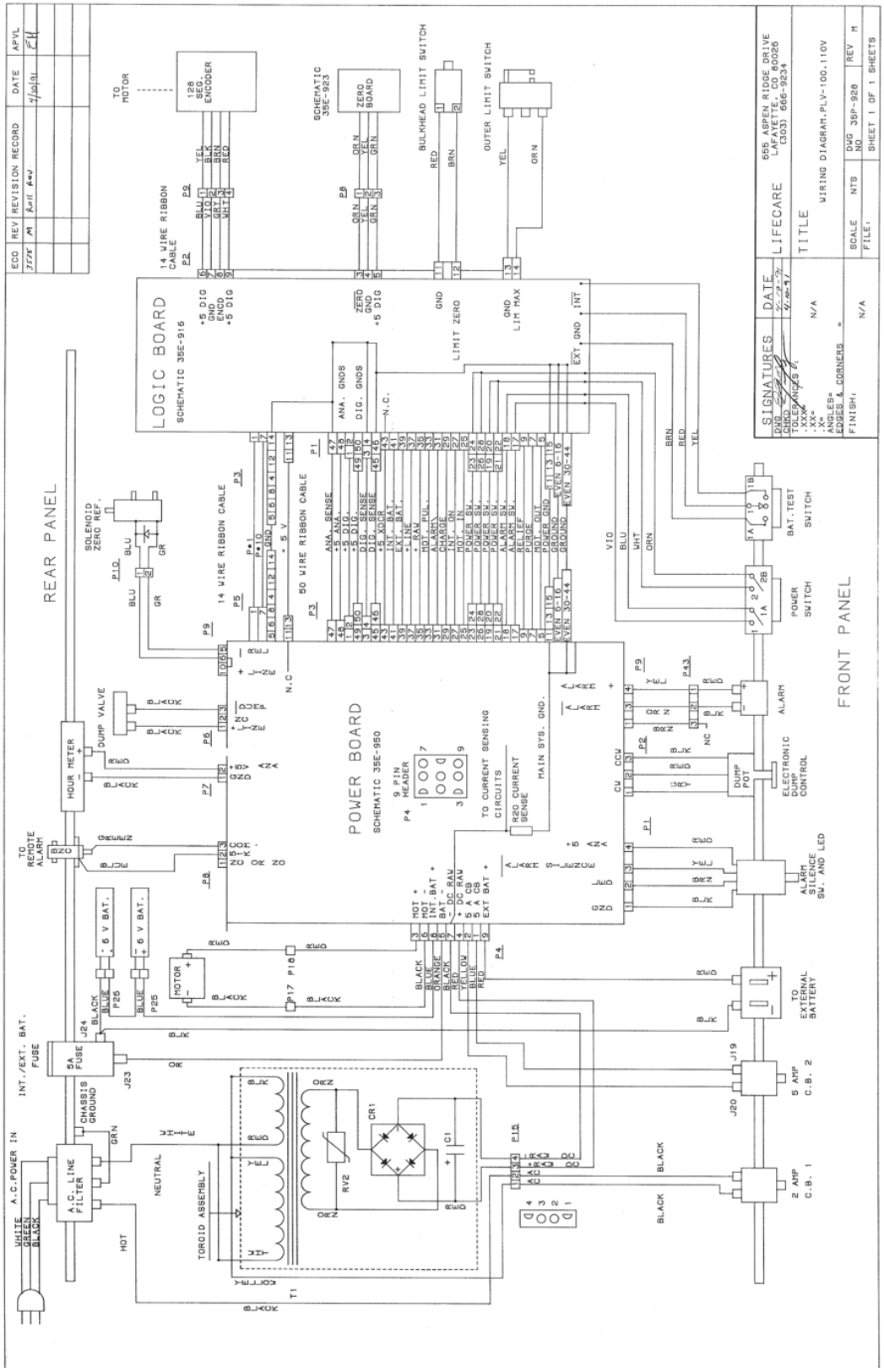
CHAPTER 15 SCHEMATICS

NOTE
The following schematics are current at the time of release of this manual.


REAR PANEL
FRONT PANEL
LOGIC BOARD
SCHEMATIC 35E-916
POWER BOARD
SCHEMATIC 35E-950
TO MOTOR
128 SEG. ENCODER
SCHEMATIC 35E-923
ZERO BOARD
BULKHEAD LIMIT SWITCH
OUTER LIMIT SWITCH
14 WIRE RIBBON CABLE
50 WIRE RIBBON CABLE
SOLENOID ZERO REF.
DUMP VALVE
HOUR METER
TO REMOTE ALARM
6 V BAT.
MOTOR
INT./EXT. BAT. FUSE
CHASSIS GROUND
A.C. LINE FILTER
A.C. POWER IN
WHITE
GREEN
BLACK
NEUTRAL
HOT
TOROID ASSEMBLY
BAT. TEST SWITCH
POWER SWITCH
ALARM
ELECTRONIC DUMP CONTROL
DUMP POT
ALARM SILENCE SW. AND LED
TO EXTERNAL BATTERY
5 AMP C.B. 2
2 AMP C.B. 1
LIFECARE
555 ASPEN RIDGE DRIVE
LAFAYETTE, CO 80026
(303) 665-9234
TITLE
WIRING DIAGRAM,PLV-100,110V
SIGNATURES
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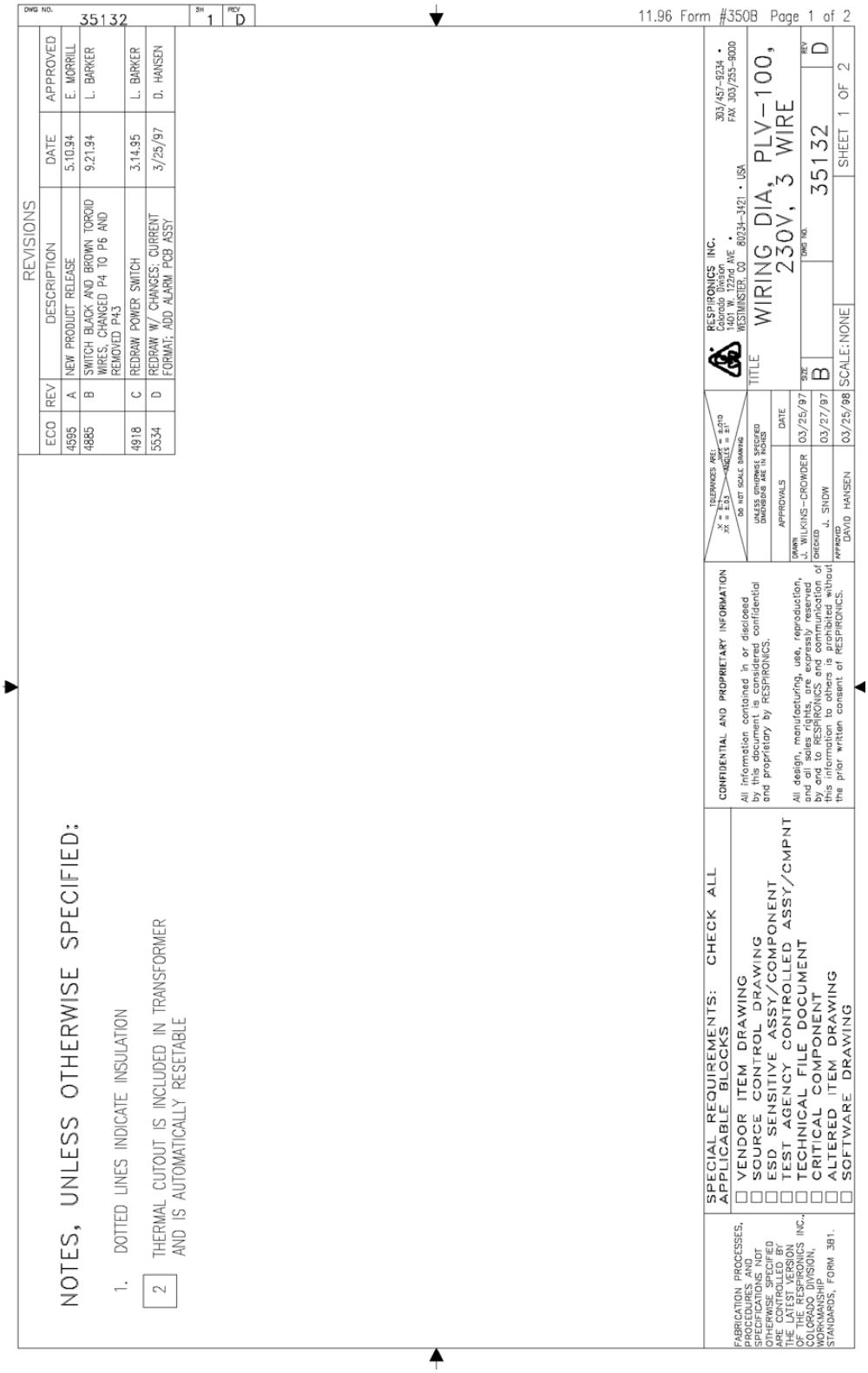
SCALE NTS
DWG 35P-920
REV M
FILE:
SHEET 1 OF 1 SHEETS
ECO
REV
REVISION RECORD
DATE
APVL


DWG NO. 35132
SH 1
REV D
11.96 Form #350B Page 1 of 2
REVISIONS
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4595 A NEW PRODUCT RELEASE 5.10.94 E. MORRILL
4885 B SWITCH BLACK AND BROWN TOROID WIRES, CHANGED P4 TO P6 AND REMOVED P43 9.21.94 L. BARKER
4918 C REDRAW POWER SWITCH 3.14.95 L. BARKER
5534 D REDRAW W/ CHANGES; CURRENT FORMAT; ADD ALARM PCB ASSY 3/25/97 D. HANSEN
NOTES, UNLESS OTHERWISE SPECIFIED:
1. DOTTED LINES INDICATE INSULATION
2 THERMAL CUTOUT IS INCLUDED IN TRANSFORMER AND IS AUTOMATICALLY RESETABLE
FABRICATION PROCESSES, PROCEDURES AND SPECIFICATIONS NOT OTHERWISE SPECIFIED ARE CONTROLLED BY THE LATEST VERSION OF THE RESPIRONICS INC., COLORADO DIVISION, WORKMANSHIP STANDARDS, FORM 381.
SPECIAL REQUIREMENTS: CHECK ALL APPLICABLE BLOCKS
☐ VENDOR ITEM DRAWING
☐ SOURCE CONTROL DRAWING
☐ ESD SENSITIVE ASSY/COMPONENT
☐ TEST AGENCY CONTROLLED ASSY/CMPNT
☐ TECHNICAL FILE DOCUMENT
☐ CRITICAL COMPONENT
☐ ALTERED ITEM DRAWING
☐ SOFTWARE DRAWING
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TOLERANCES ARE: XX = ±.03 XXX = ±.010 ANGLES = ±2°
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
APPROVALS DATE
DRAWN J. WILKINS-CROWDER 03/25/97
CHECKED J. SNOW 03/27/97
APPROVED DAVID HANSEN 03/25/98
RESPIRONICS INC.
Colorado Division
1401 W. 122nd AVE
WESTMINSTER, CO 80234-3421 • USA
303/457-9234 •
FAX 303/255-9000
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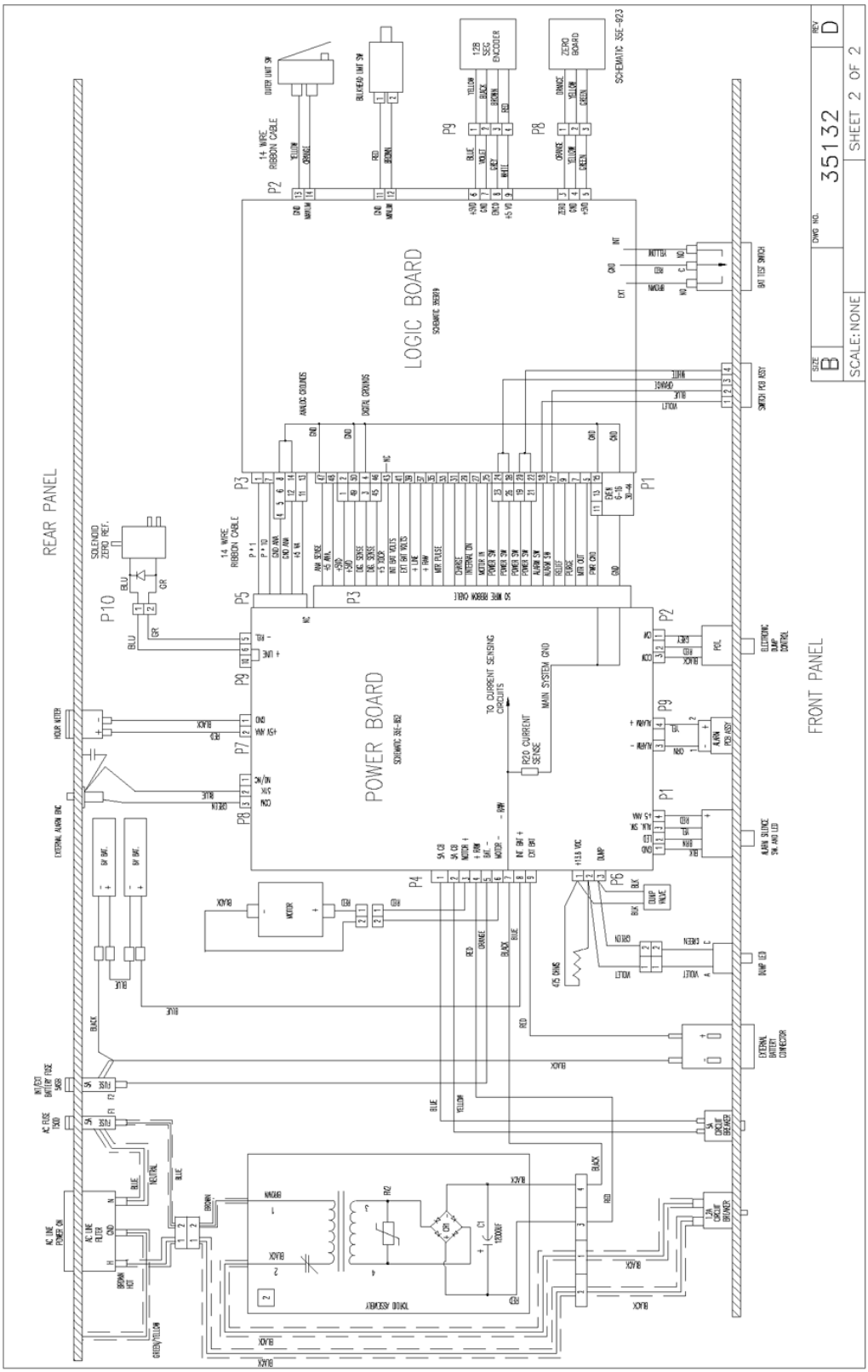
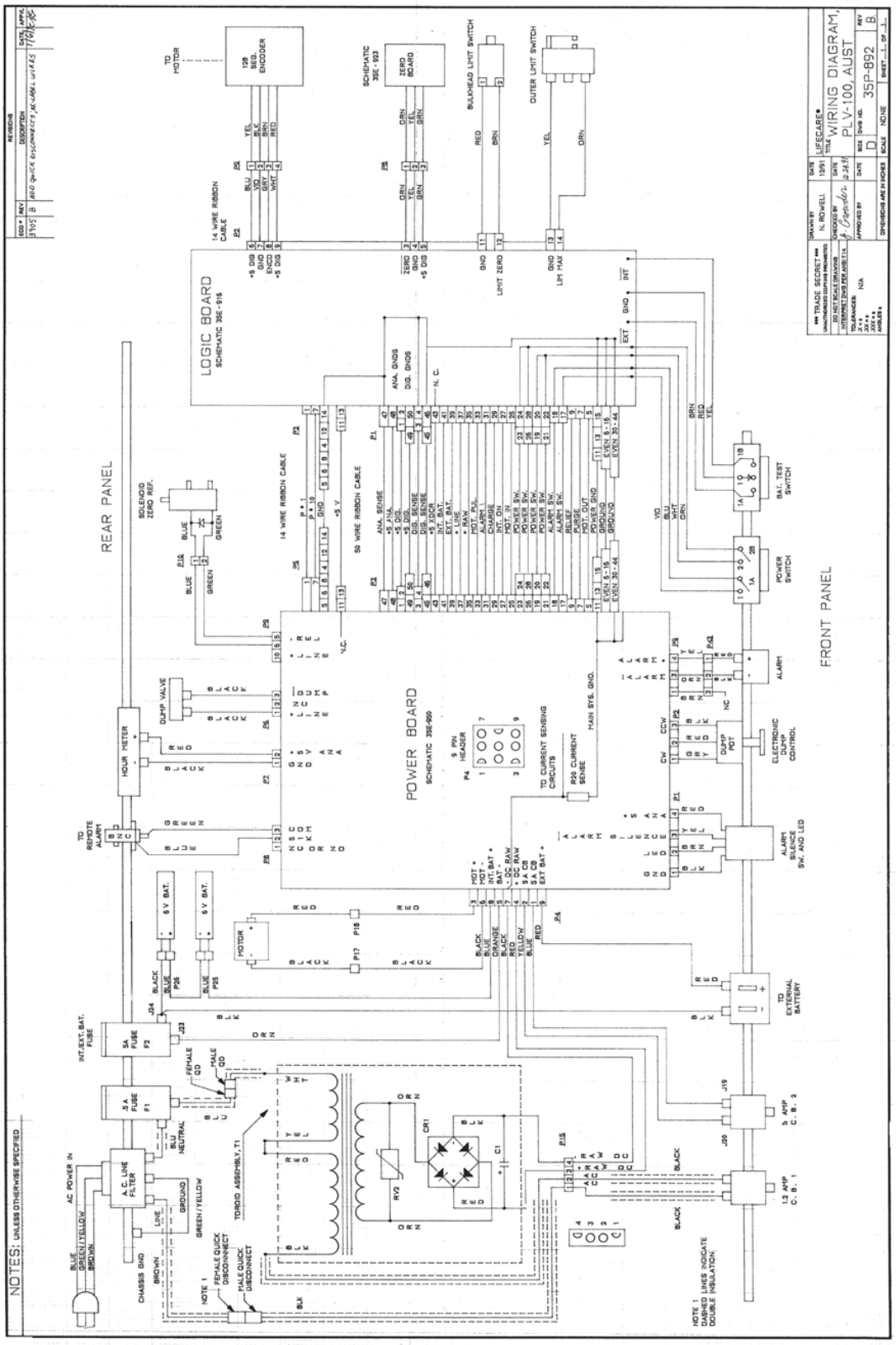
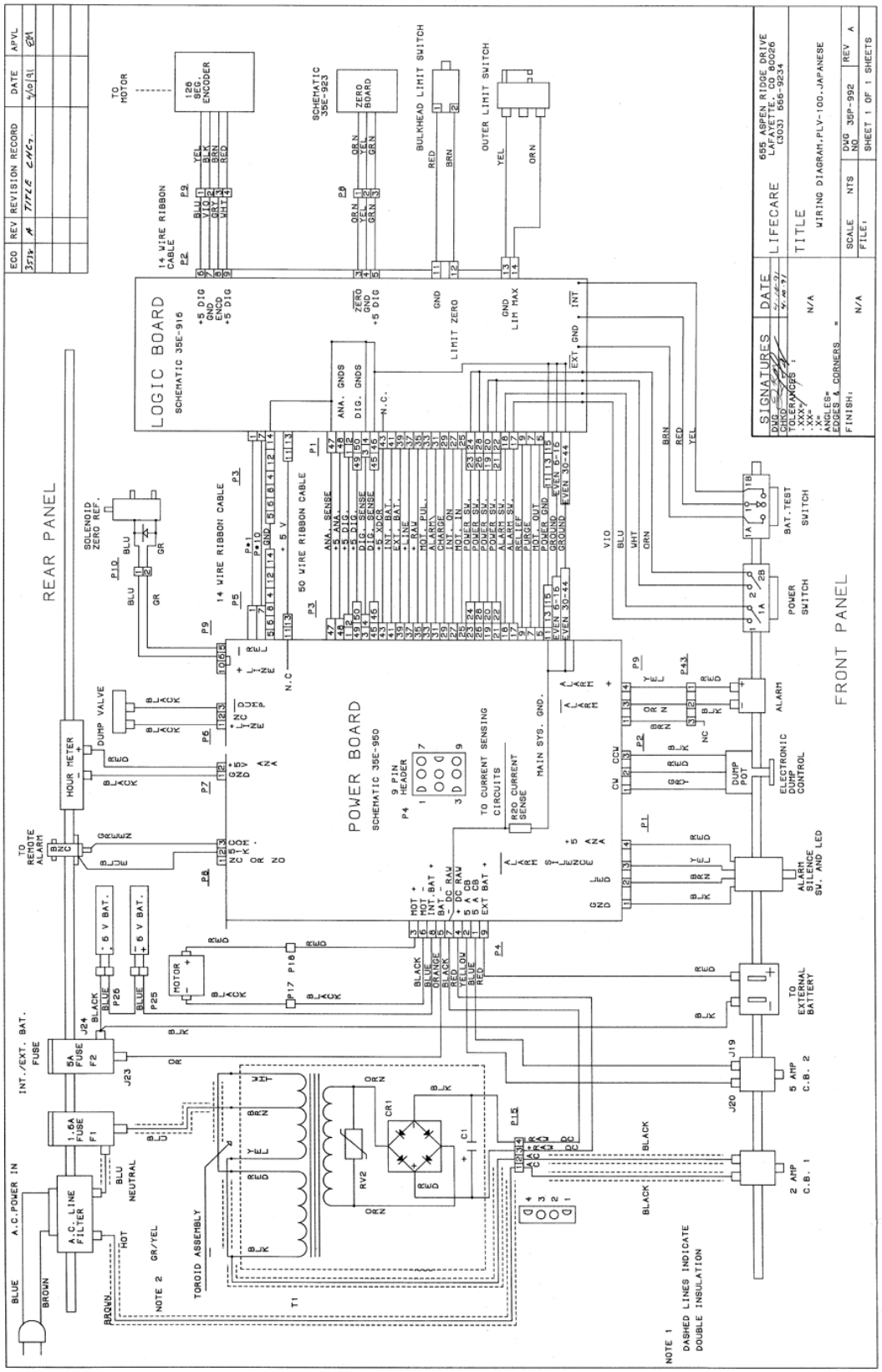
SIZE B
DWG NO. 35132
REV D
SCALE: NONE
SHEET 1 OF 2


REAR PANEL
FRONT PANEL
LOGIC BOARD
POWER BOARD
SCHEMATIC 35E-823
SIZE B
DWG NO. 35132
REV D
SCALE: NONE
SHEET 2 OF 2


WIRING DIAGRAM, PLV-100, AUST
35P-892
LOGIC BOARD
SCHEMATIC 35E-916
POWER BOARD
SCHEMATIC 35E-920
REAR PANEL
FRONT PANEL
NOTES: UNLESS OTHERWISE SPECIFIED
LIFECARE
TRADE SECRET
14 WIRE RIBBON CABLE
50 WIRE RIBBON CABLE
128 SEG. ENCODER
ZERO BOARD
BULKHEAD LIMIT SWITCH
OUTER LIMIT SWITCH
HOUR METER
DUMP VALVE
SOLENOID ZERO REF.
BAT. TEST SWITCH
POWER SWITCH
ALARM
ELECTRONIC DUMP CONTROL
DUMP POT
ALARM SILENCE SW. AND LED
TO EXTERNAL BATTERY
TO REMOTE ALARM
TO CURRENT SENSING CIRCUITS
MAIN SYS. GND.
INT./EXT. BAT. FUSE
5A FUSE F2
3.5A FUSE F1
A.C. LINE FILTER
TOROID ASSEMBLY, T1
6 V BAT.
MOTOR
AC POWER IN
CHASSIS GND
NEUTRAL
GROUND
FEMALE QUICK DISCONNECT
MALE QUICK DISCONNECT


LOGIC BOARD
SCHEMATIC 35E-916
POWER BOARD
SCHEMATIC 35E-950
REAR PANEL
FRONT PANEL
LIFECARE
655 ASPEN RIDGE DRIVE
LAFAYETTE, CO 80026
(303) 666-9234
TITLE
WIRING DIAGRAM,PLV-100,JAPANESE
SCALE NTS
DWG NO 35P-992
REV A
SHEET 1 OF 1 SHEETS
SIGNATURES
DATE
N/A
N/A
ECO
REV
REVISION RECORD
DATE
APVL
14 WIRE RIBBON CABLE
50 WIRE RIBBON CABLE
128 SEG. ENCODER
SCHEMATIC 35E-923
ZERO BOARD
BULKHEAD LIMIT SWITCH
OUTER LIMIT SWITCH
SOLENOID ZERO REF.
DUMP VALVE
HOUR METER
TO REMOTE ALARM
6 V BAT.
MOTOR
5A FUSE F2
1.6A FUSE F1
INT./EXT. BAT. FUSE
A.C. LINE FILTER
A.C.POWER IN
TOROID ASSEMBLY
BAT. TEST SWITCH
POWER SWITCH
ALARM
ELECTRONIC DUMP CONTROL
DUMP POT
ALARM SILENCE SW. AND LED
TO EXTERNAL BATTERY
5 AMP C.B. 2
2 AMP C.B. 1
NOTE 1
DASHED LINES INDICATE DOUBLE INSULATION
NOTE 2

REVISIONS

ECO	REV	DESCRIPTION	DATE	APPROVED
4294	A	INITIAL RELEASE	9/16/92	E. MORRILL
5267	B	TITLE WAS DIAGRAM, WIRING, PLV-100, SWEDISH	11/8/95	L. E. BARKER
5540	C	REDRAW W/ CHANGES; CURRENT FORMAT; ADD ALARM PCB ASSY	04/10/97	D. HANSEN

NOTES, UNLESS OTHERWISE SPECIFIED:

1. DOTTED LINES INDICATE INSULATED TUBING

SPECIAL REQUIREMENTS: CHECK ALL APPLICABLE BLOCKS

- ☐ VENDOR ITEM DRAWING
- ☐ SOURCE CONTROL DRAWING
- ☐ ESD SENSITIVE ASSY/COMPONENT
- ☐ TEST AGENCY CONTROLLED ASSY/CMPNT
- ☐ TECHNICAL FILE DOCUMENT
- ☐ CRITICAL COMPONENT
- ☐ ALTERED ITEM DRAWING
- ☐ SOFTWARE DRAWING

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.XX = ±.40
.XXX = ±.010
ANGLES = ±1°

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

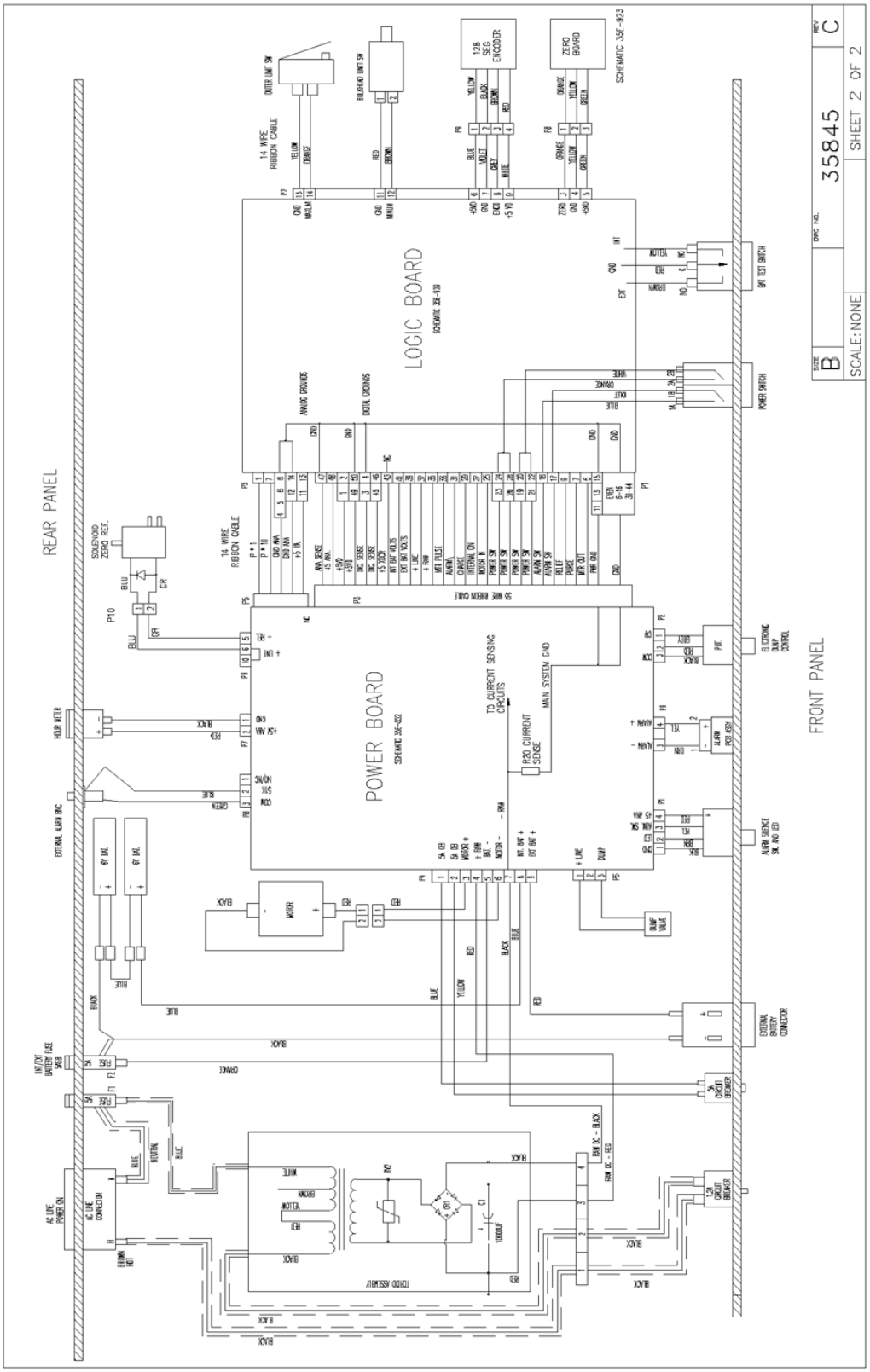
APPROVALS	DATE
DRAWN J. WILKINS–CROWDER	04/09/97
CHECKED J. SNOW	4/11/97
APPROVED DAVID HANSEN	4/10/97

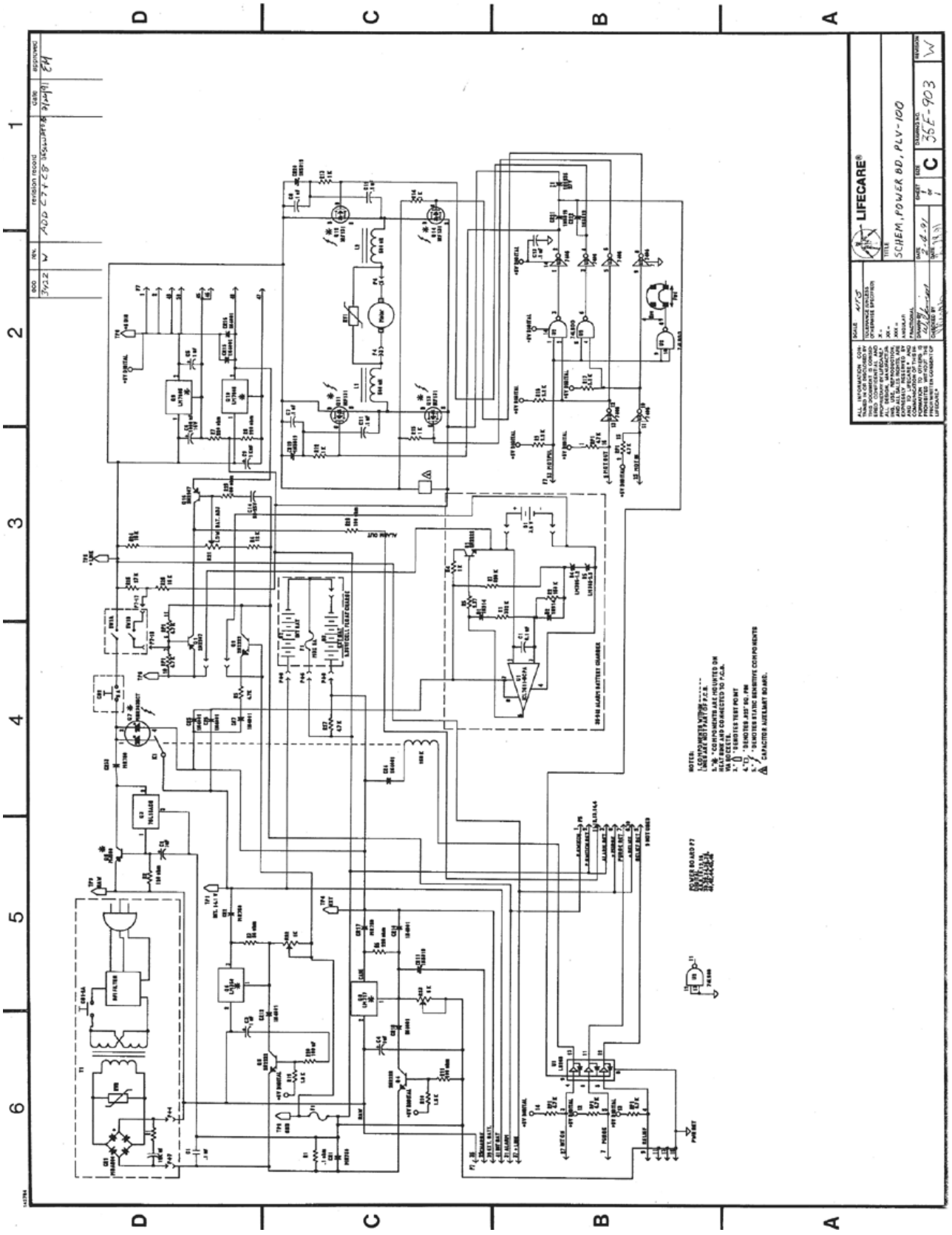
RESPIRONICS Colorado Inc.
1475 W. 124TH AVE
WESTMINSTER, CO 80234–3421 • USA
303/457–9234 •
FAX 303/255–9000

TITLE: DIAGRAM, WIRING, PLV–100, 2 WIRE

SIZE: B
DWG NO: 35845
REV: C

SCALE: NONE
SHEET 1 OF 2


REAR PANEL
FRONT PANEL
LOGIC BOARD
POWER BOARD
SCHEMATIC 35E-923
SCALE: NONE
SHEET 2 OF 2
35845
SIZE B
REV C


LIFECARE®
SCHEM, POWER BD, PLV-100
SIZE C
36E-903
REV W
D
C
B
A
1
2
3
4
5
6

DWG NO. 35E-916 | SHEET 1 | REV W

REVISIONS				
ECO	REV	DESCRIPTION	DATE	APPROVED
3909	U	ROLL REV TO MATCH BOM	1/6/92	J. SHACKELFORD
4067	V	CORRECT DESCRIPTION	4/10/92	J. SHACKELFORD
4791	W	SH 4: C31 WAS C36; C37 NOT PRESENT	8/10/94	L. du[illegible]

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.XX = ±.03 ANGLES = ±1°
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES

APPROVALS	DATE
DRAWN D. VOYLES	8/9/94
CHECKED L. du[illegible]	8/10/94
APPROVED L. du[illegible]	8/10/94

LIFECARE INTERNATIONAL, INC.
655 ASPEN RIDGE DRIVE • LAFAYETTE, CO 80026-9341 • USA
303/666-9234 • FAX 303/666-0415

TITLE SCHEM,DIGITAL BOARD,PLV-100

SIZE A | DWG NO. 35E-916 | REV W

SCALE NONE | SHEET 1 OF 5

8.93 Form #355A1

DWG NO. 35E-916 | SHEET 2 | REV W

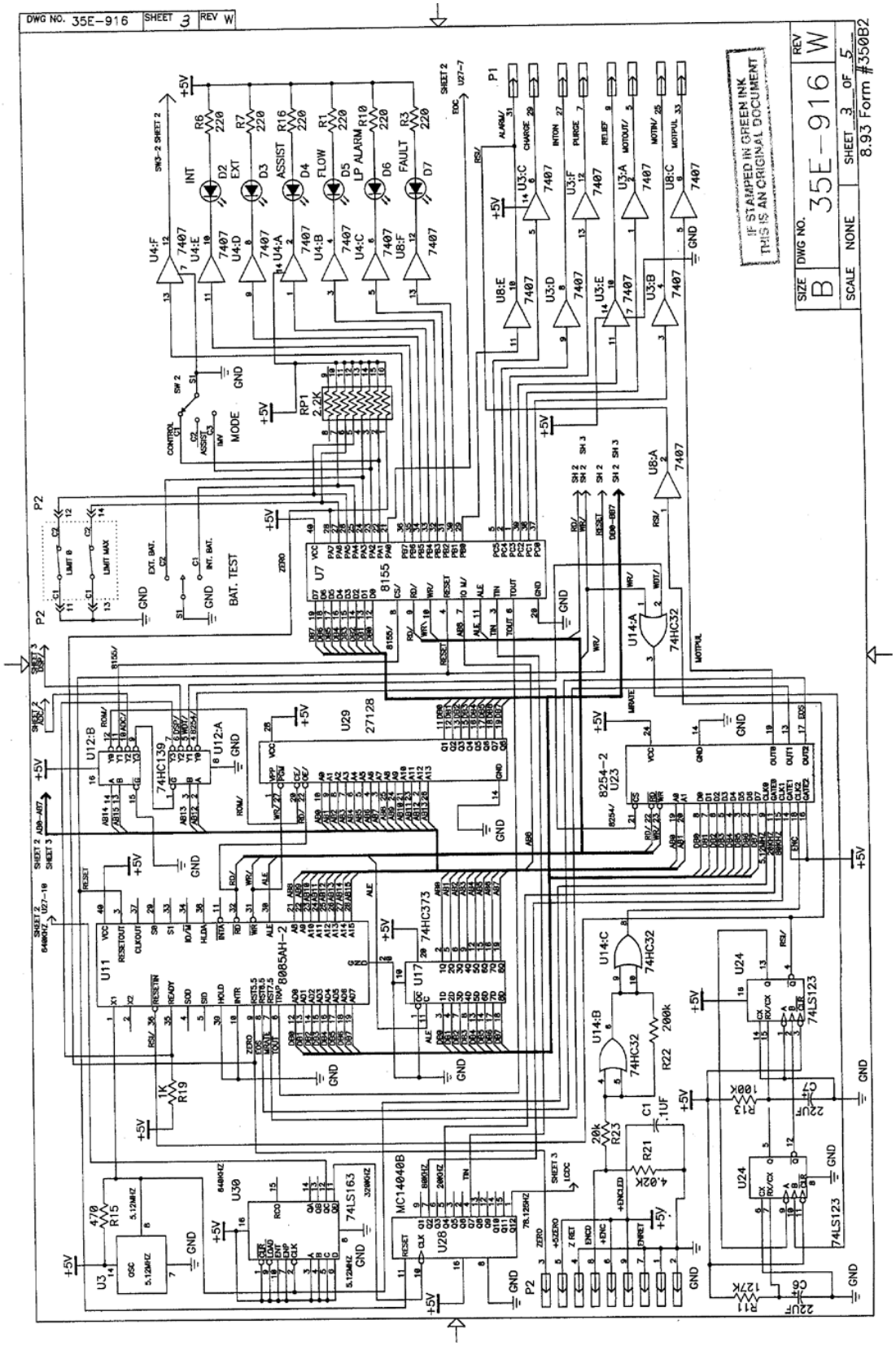
1. SW3 DRAWN IN DOMESTIC MODE

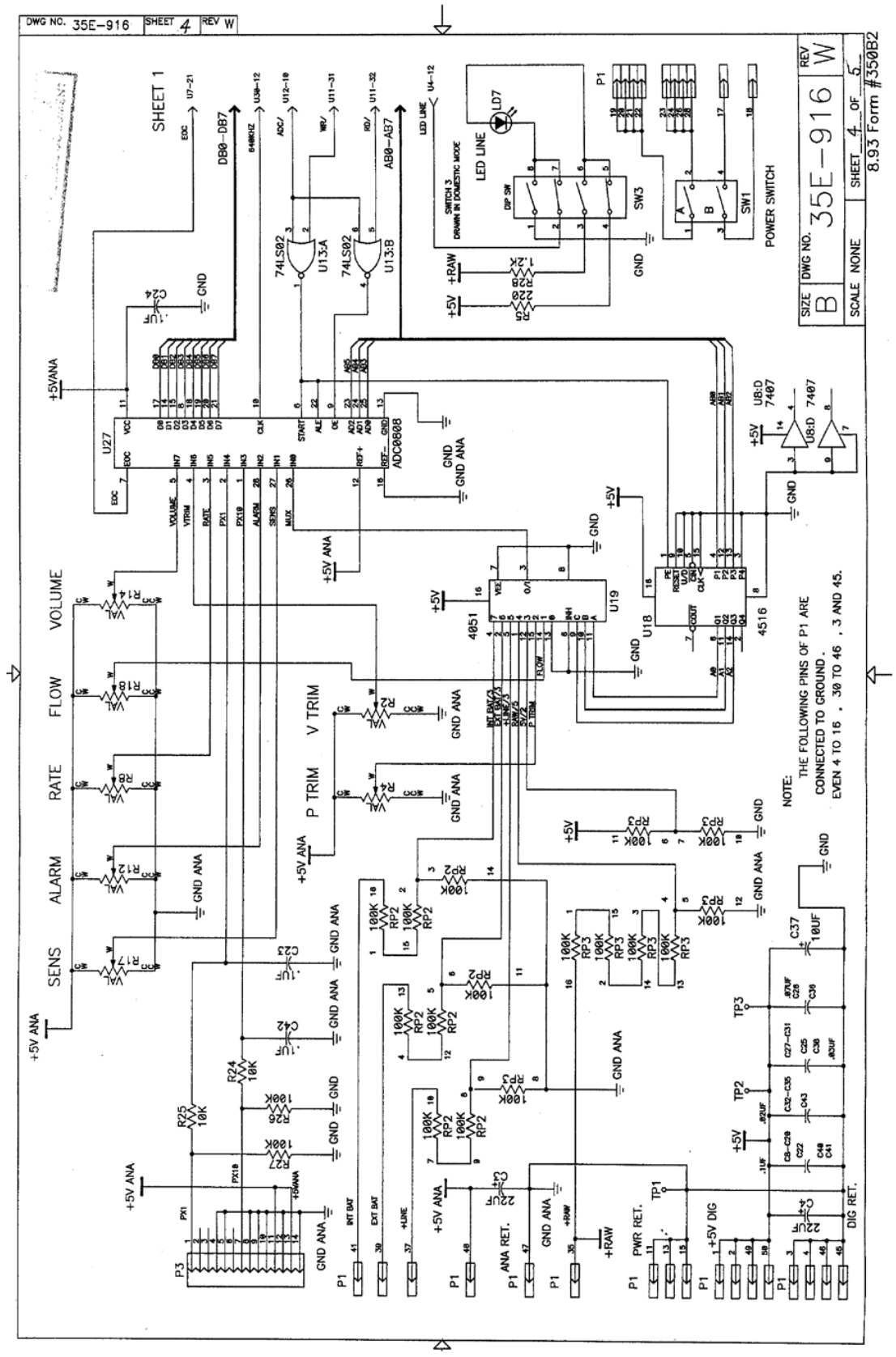
2. THIS SCHEMATIC REPRESENTS BOTH THE 35-916 DIGITAL BOARD AND THE 35-929 DIGITAL BOARD. 35-929 WILL HAVE A YELLOW LED IN D6 AND THE SWITCH WILL BE IN THE INTERNATIONAL POSITION.

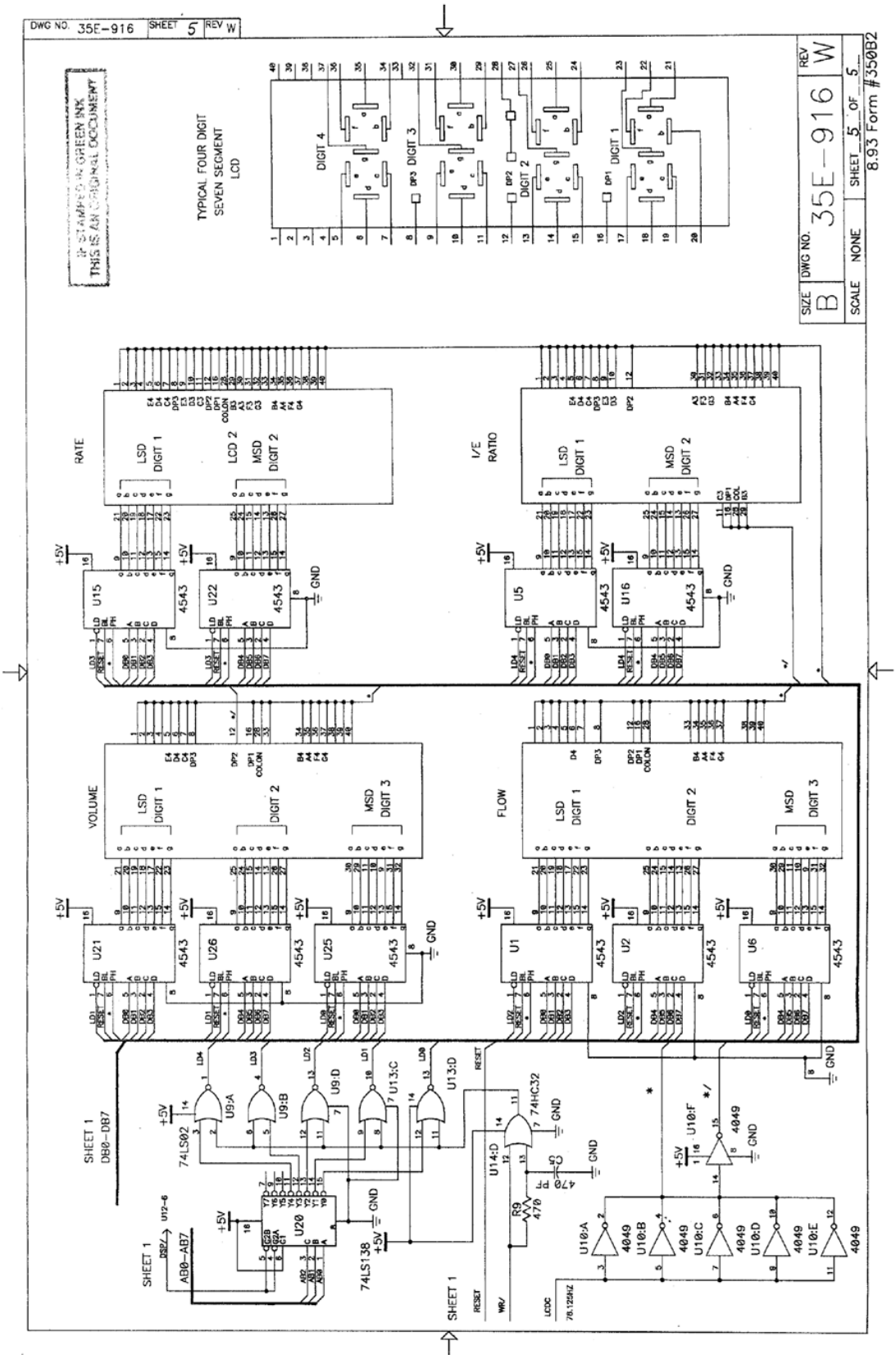
IF STAMPED IN GREEN INK
THIS IS AN ORIGINAL DOCUMENT

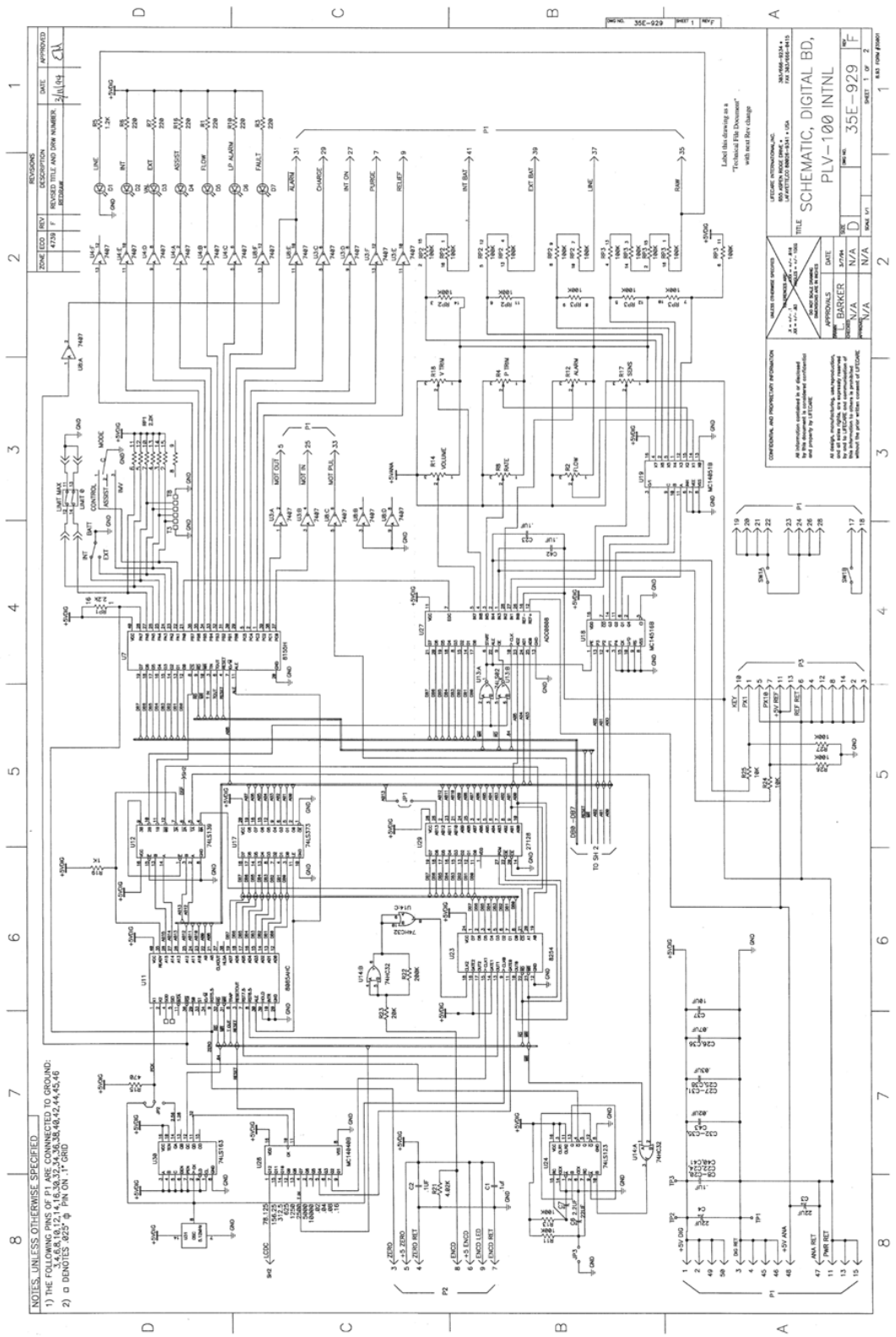
8.93 Form #355A2

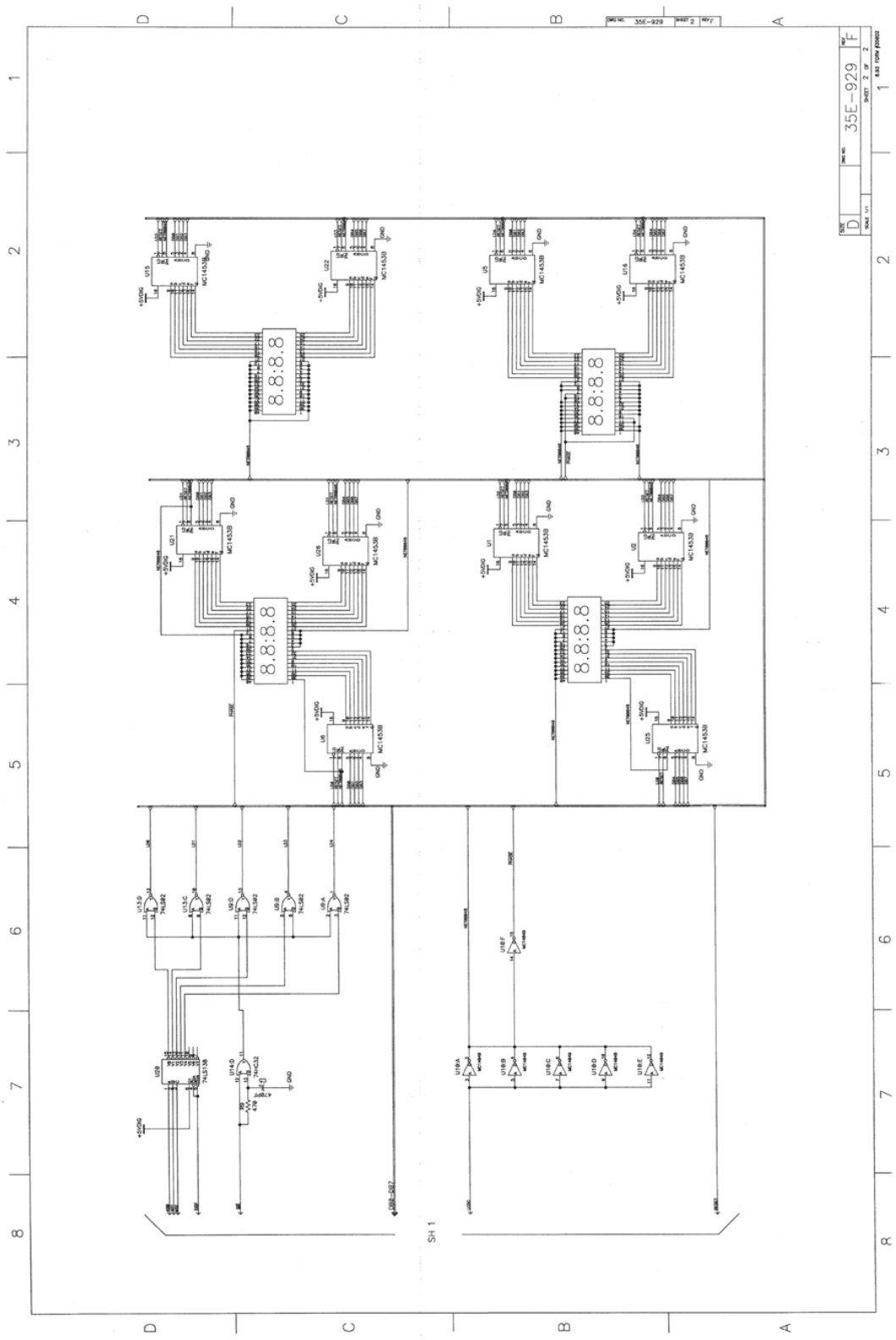
SIZE	DWG NO.	REV
A	35E-916	W
SCALE:NONE	SHEET 2 OF 5	

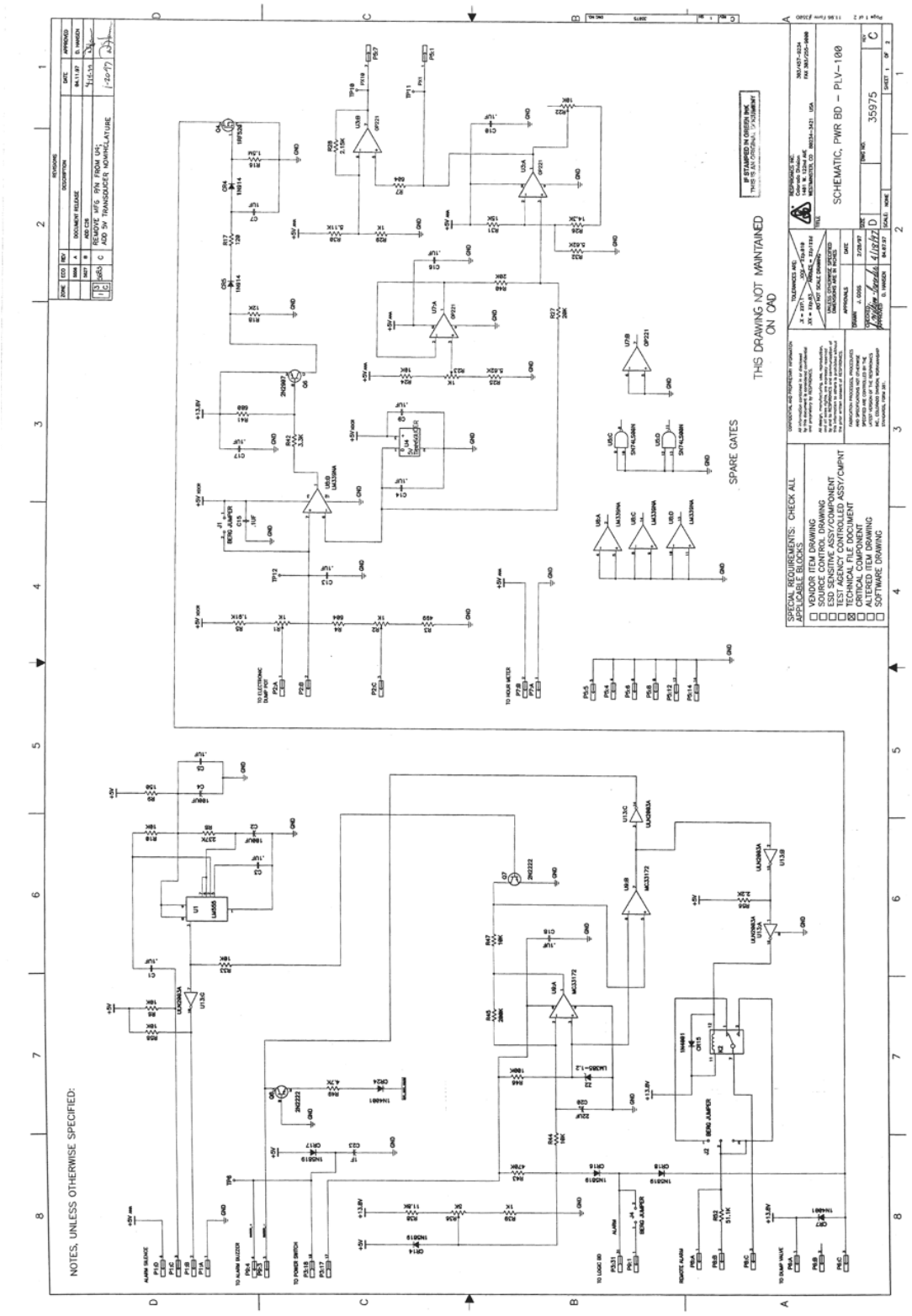

DWG NO. 35E-916
SHEET 3
REV W
SIZE B
DWG NO. 35E-916
REV W
SCALE NONE
SHEET 3 OF 5
8.93 Form #350B2
IF STAMPED IN GREEN INK THIS IS AN ORIGINAL DOCUMENT
INT
EXT
ASSIST
FLOW
LP ALARM
FAULT
MODE
BAT. TEST
U7
8155
U29
27128
U11
8085AH-2
U17
74HC373
U28
MC14040B
U30
74LS163
U3
74HC139
U14:A
74HC32
U14:B
74HC32
U14:C
74HC32
U23
8254-2
U24
74LS123
U8:A
7407
U8:C
7407
U8:E
7407
U8:F
7407
U3:A
7407
U3:B
7407
U3:C
7407
U3:D
7407
U3:E
7407
U3:F
7407
U4:A
7407
U4:B
7407
U4:C
7407
U4:D
7407
U4:E
7407
U4:F
7407
U12:A
74HC139
U12:B
74HC139
RP1
2.2K
R1
220
R3
220
R6
220
R7
220
R10
220
R16
220
R19
1K
R15
470
R22
200k
R23
20k
R21
20K
C1
.1UF
C7
22UF
C8
22UF
R11
127K
R12
100K
P1
P2
SW 2
SW3-2 SHEET 2
+5V
GND

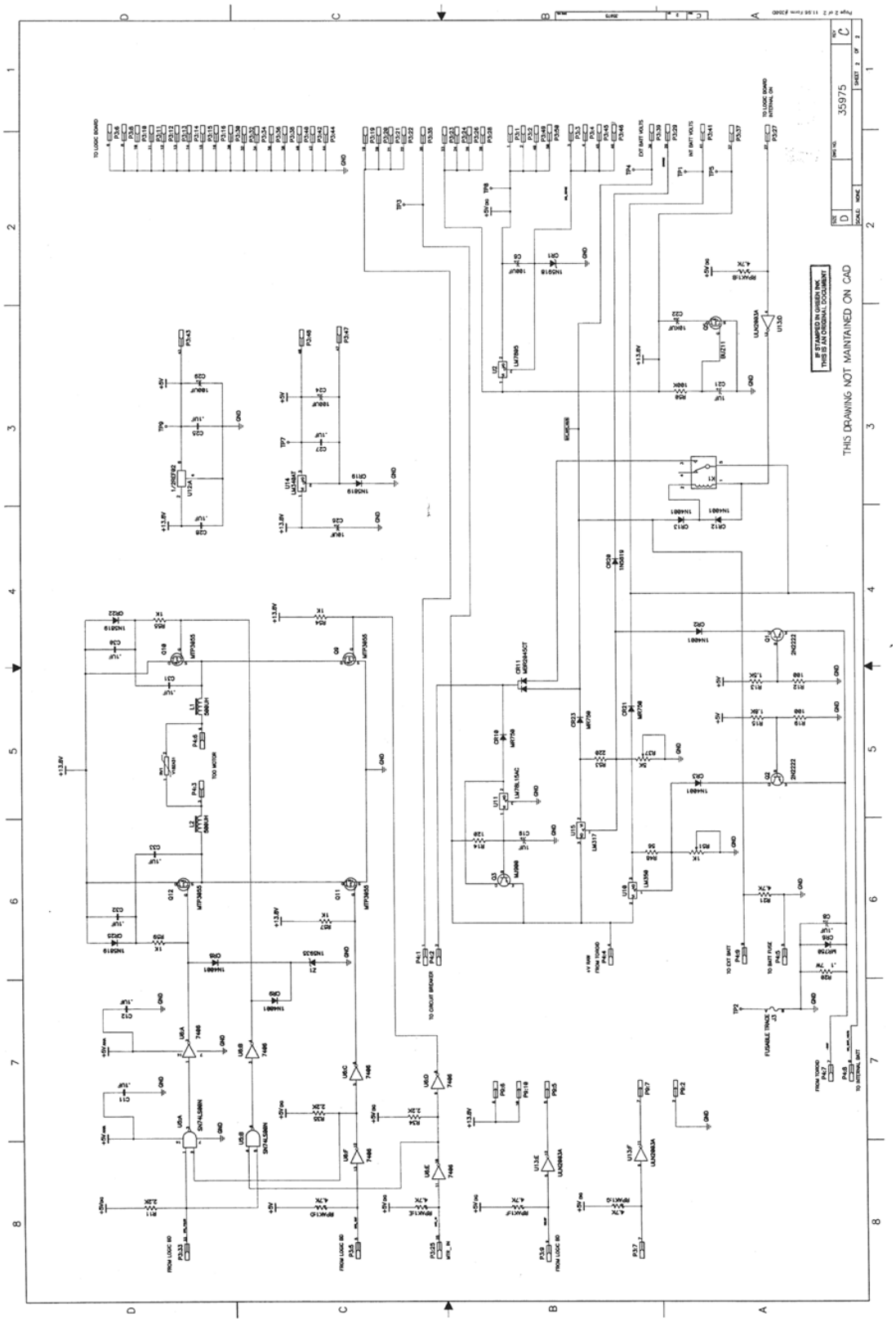

DWG NO. 35E-916
SHEET 4
REV W
SHEET 1
DB0-DB7
AB0-AB7
LED LINE
SW3
SW1
POWER SWITCH
U27
ADC0808
U13:A
U13:B
74LS02
U19
4051
U18
4516
U8:D 7407
VOLUME
FLOW
RATE
ALARM
SENS
V TRIM
P TRIM
+5V ANA
GND ANA
+5V
GND
+RAW
ANA RET.
PWR RET.
+5V DIG
DIG RET.
NOTE:
THE FOLLOWING PINS OF P1 ARE
CONNECTED TO GROUND.
EVEN 4 TO 16 , 30 TO 46 , 3 AND 45.
SIZE B
DWG NO. 35E-916
REV W
SCALE NONE
SHEET 4 OF 5
8.93 Form #350B2

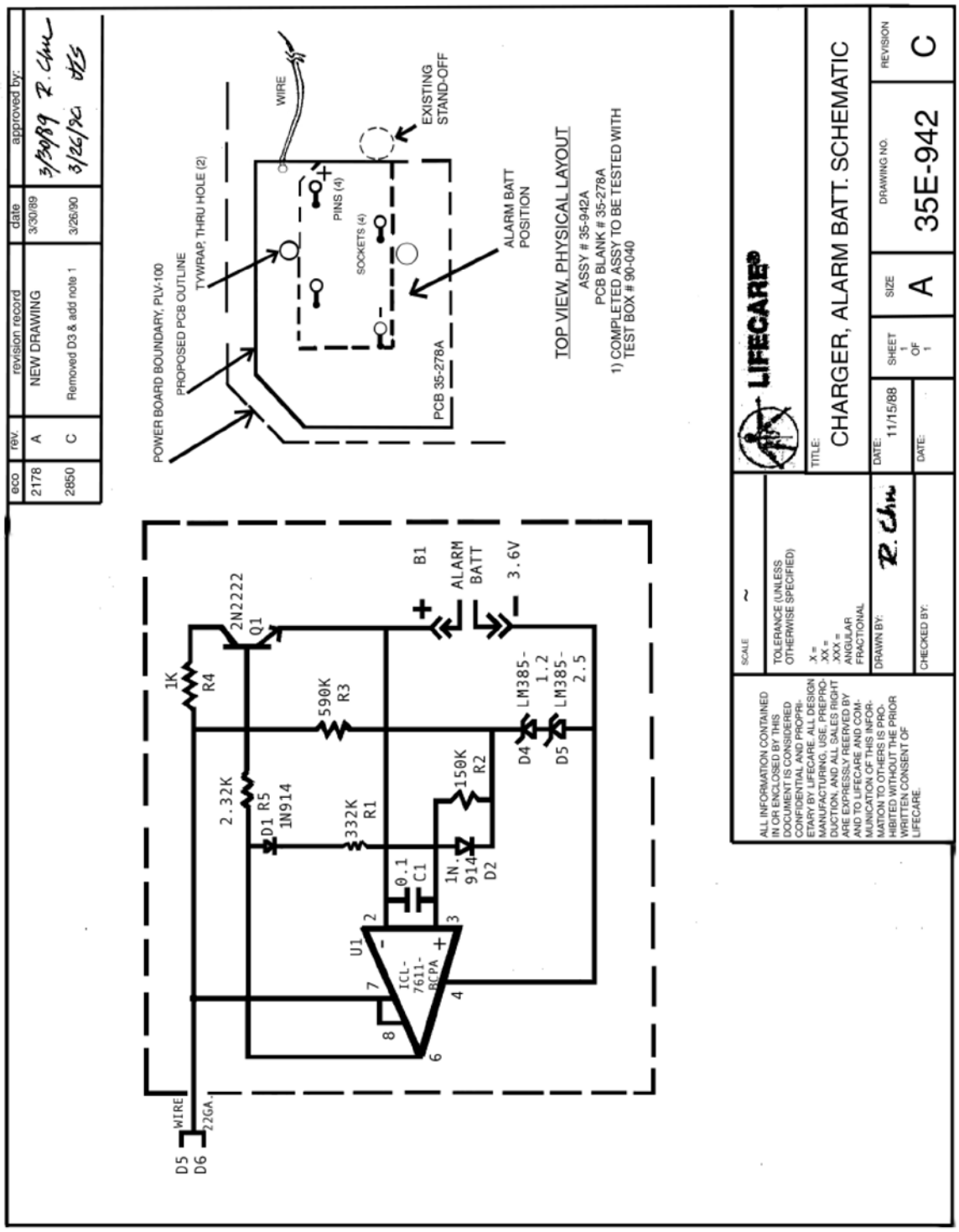

DWG NO. 35E-916
SHEET 5
REV W
TYPICAL FOUR DIGIT SEVEN SEGMENT LCD
DIGIT 4
DIGIT 3
DIGIT 2
DIGIT 1
SIZE B
DWG NO. 35E-916
REV W
SCALE NONE
SHEET 5 OF 5
8.93 Form #350B2
RATE
LSD DIGIT 1
LCD 2
MSD DIGIT 2
I/E RATIO
VOLUME
DIGIT 2
MSD DIGIT 3
FLOW
+5V
GND
4543
74LS02
74LS138
74HC32
4049
SHEET 1
DB0-DB7
AB0-AB7
RESET
470 PF
R9 470


SCHEMATIC, DIGITAL BD,
PLV-100 INTNL
35E-929
NOTES, UNLESS OTHERWISE SPECIFIED
1) THE FOLLOWING PINS OF P1 ARE CONNECTED TO GROUND:
3,4,6,8,10,12,14,16,28,32,34,36,38,42,44,45,46
2) □ DENOTES .625 ϕ PIN ON .1" GRID


35E-929
SHEET 2 OF 2
REV F
SIZE D
8.8:8.8
MC14538
74LS38
74HC32
74HC86
SH 1


SCHEMATIC, PWR BD – PLV–100
35975
THIS DRAWING NOT MAINTAINED ON CAD
SPARE GATES
NOTES, UNLESS OTHERWISE SPECIFIED:


THIS DRAWING NOT MAINTAINED ON CAD
35975


eco rev. revision record date approved by:
2178 A NEW DRAWING 3/30/89 3/30/89 R. Chu
2850 C Removed D3 & add note 1 3/26/90 3/26/90
POWER BOARD BOUNDARY, PLV-100
PROPOSED PCB OUTLINE
TYWRAP, THRU HOLE (2)
WIRE
PINS (4)
SOCKETS (4)
EXISTING STAND-OFF
ALARM BATT POSITION
PCB 35-278A
TOP VIEW, PHYSICAL LAYOUT
ASSY # 35-942A
PCB BLANK # 35-278A
1) COMPLETED ASSY TO BE TESTED WITH TEST BOX # 90-040
B1
ALARM BATT
3.6V
2N2222
Q1
1K
R4
590K
R3
2.32K
D1 R5
1N914
332K
R1
150K
R2
D4
D5
LM385-1.2
LM385-2.5
0.1
C1
1N914
D2
U1
ICL-7611-BCPA
D5
D6
WIRE
22GA
LIFECARE
SCALE ~
TOLERANCE (UNLESS OTHERWISE SPECIFIED)
X =
XX =
XXX =
ANGULAR
FRACTIONAL
DRAWN BY: R. Chu
DATE: 11/15/88
CHECKED BY:
DATE:
TITLE: CHARGER, ALARM BATT. SCHEMATIC
SHEET 1 OF 1
SIZE A
DRAWING NO. 35E-942
REVISION C
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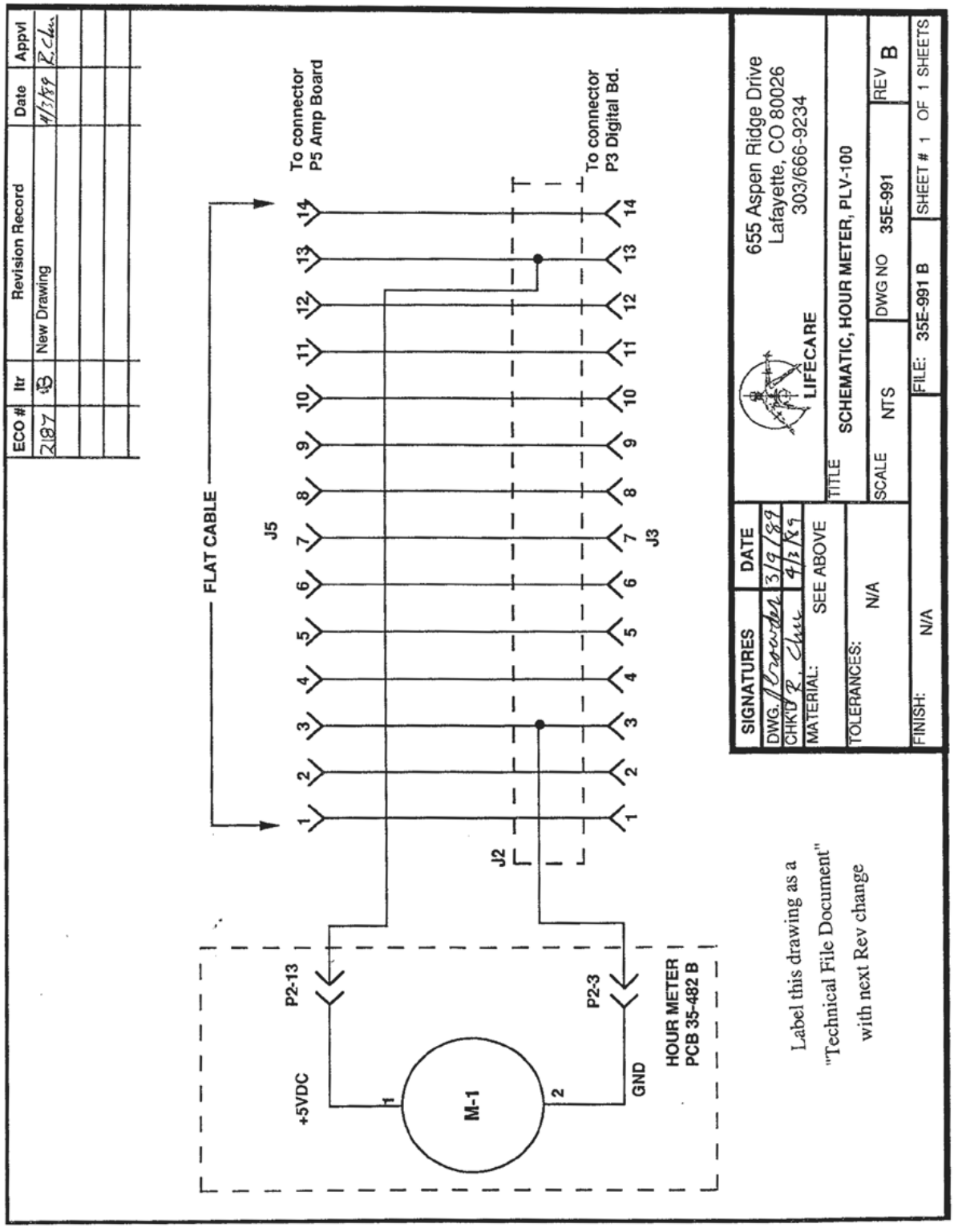
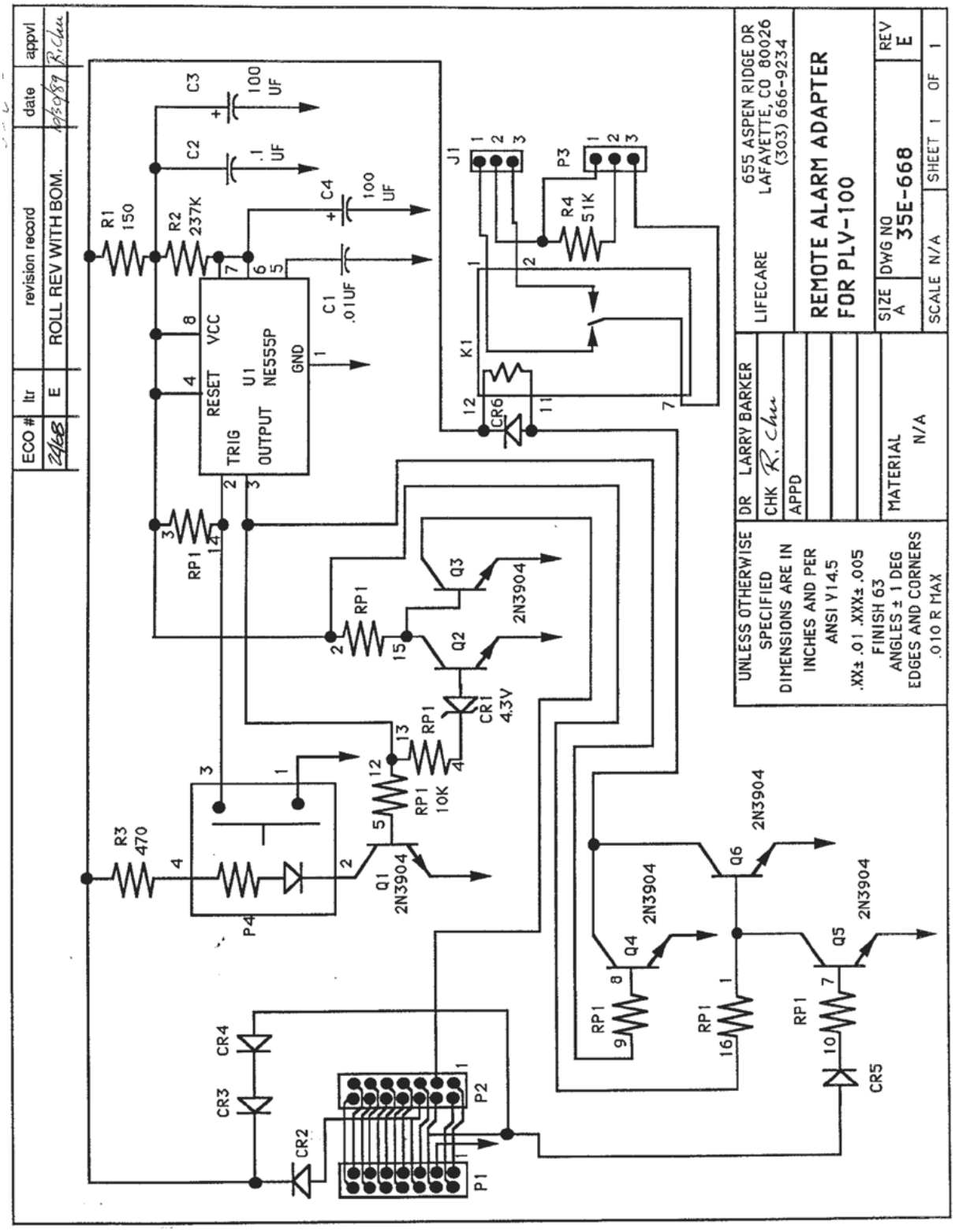
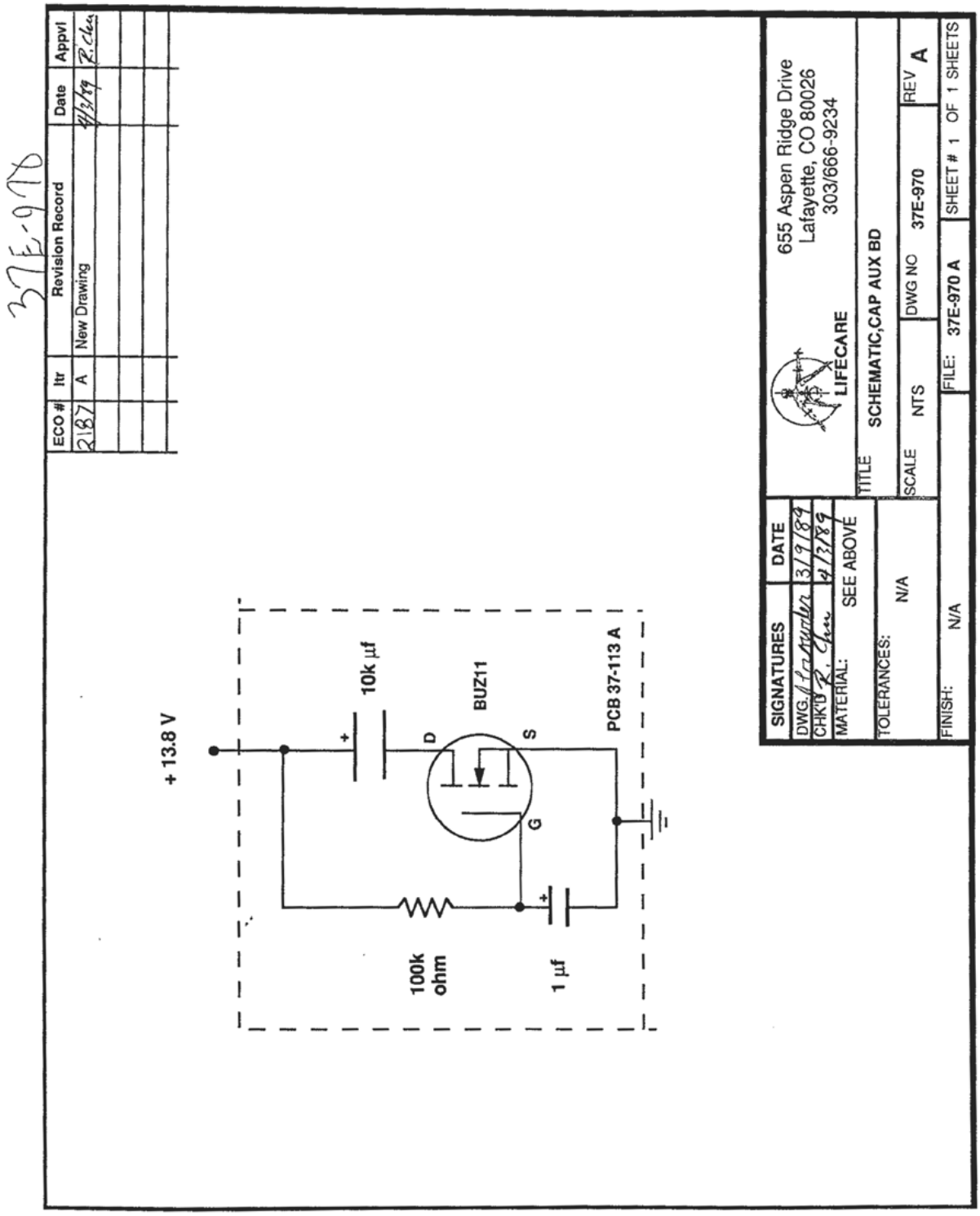
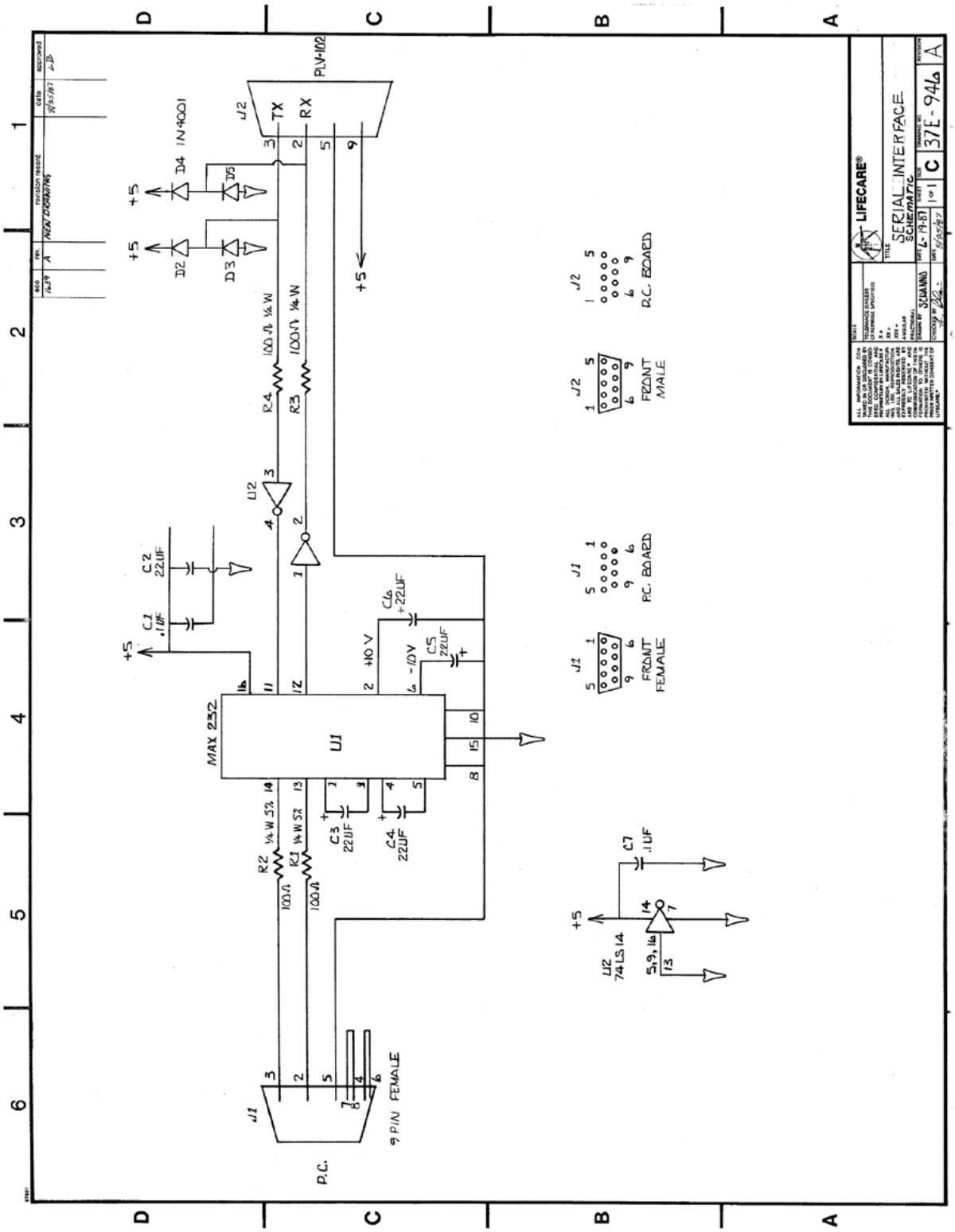
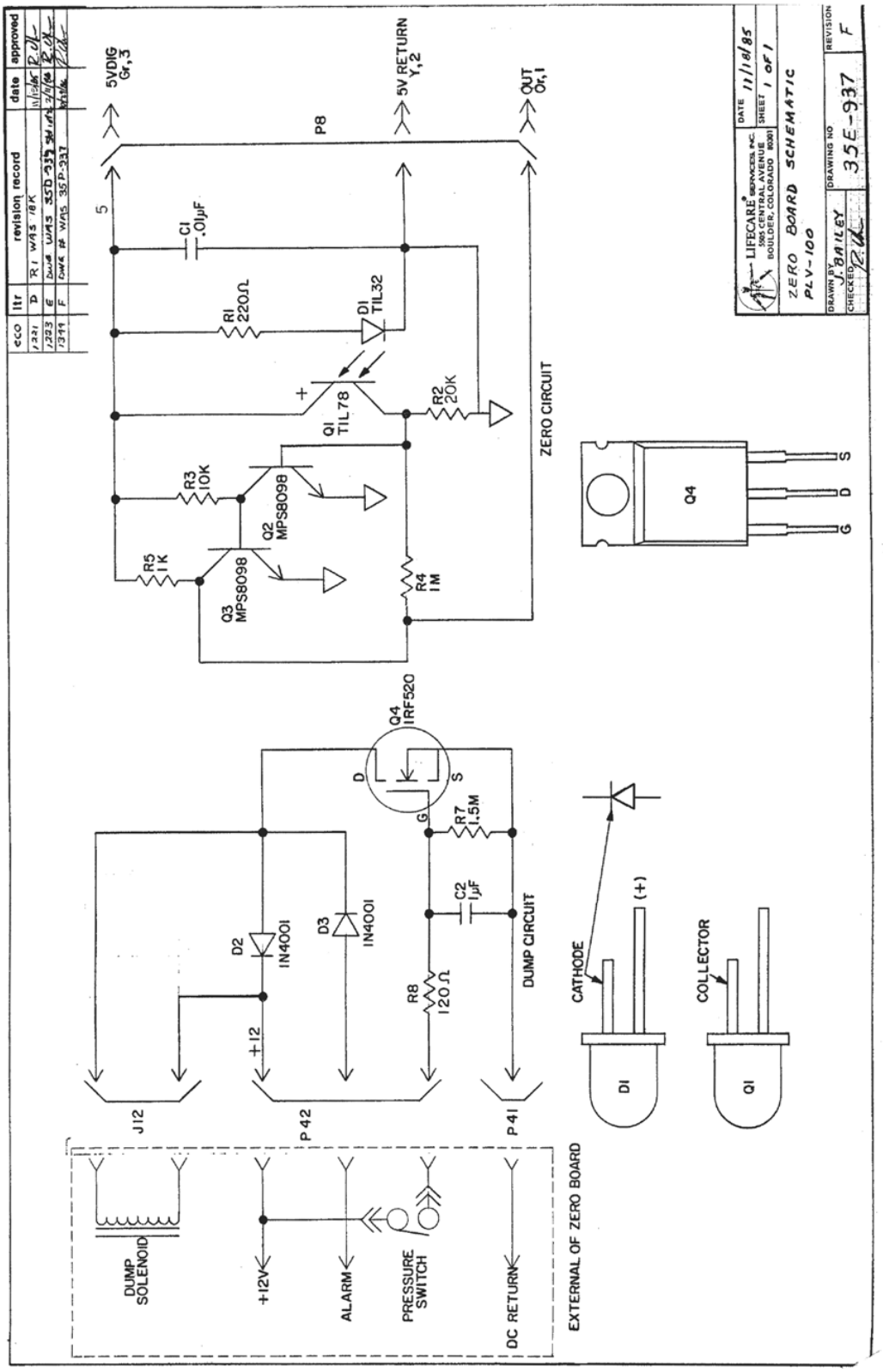

ECO # | Ltr | Revision Record | Date | Appvl
2187 | B | New Drawing | 4/3/89 | R.Chu
To connector P5 Amp Board
To connector P3 Digital Bd.
FLAT CABLE
J5
J3
J2
P2-13
P2-3
+5VDC
GND
M-1
HOUR METER PCB 35-482 B
Label this drawing as a "Technical File Document" with next Rev change
SIGNATURES | DATE
DWG. | CHK'D | MATERIAL: SEE ABOVE
TOLERANCES: N/A
FINISH: N/A
655 Aspen Ridge Drive
Lafayette, CO 80026
303/666-9234
LIFECARE
TITLE SCHEMATIC, HOUR METER, PLV-100
SCALE NTS
DWG NO 35E-991
REV B
FILE: 35E-991 B
SHEET # 1 OF 1 SHEETS


ECO # | ltr | revision record | date | appvl
E | ROLL REV WITH BOM. | 10/30/97 | R.Chu
LIFECARE
655 ASPEN RIDGE DR
LAFAYETTE, CO 80026
(303) 666-9234
REMOTE ALARM ADAPTER
FOR PLV-100
SIZE A | DWG NO 35E-668 | REV E
SCALE N/A | SHEET 1 OF 1
DR LARRY BARKER
CHK R. Chu
APPD
MATERIAL N/A
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND PER ANSI Y14.5
.XX± .01 .XXX± .005
FINISH 63
ANGLES ± 1 DEG
EDGES AND CORNERS .010 R MAX
R1 150
R2 237K
R3 470
R4 51K
C1 .01UF
C2 .1 UF
C3 100 UF
C4 100 UF
U1 NE555P
VCC
RESET
TRIG
OUTPUT
GND
RP1
RP1 10K
CR1 4.3V
CR2
CR3
CR4
CR5
CR6
K1
J1
P1
P2
P3
P4
Q1 2N3904
Q2 2N3904
Q3 2N3904
Q4 2N3904
Q5 2N3904
Q6 2N3904


37E-970
ECO # | ltr | Revision Record | Date | Appvl
2187 | A | New Drawing | 4/8/89 | R.Chu
+ 13.8 V
10k µf
BUZ11
D
S
G
PCB 37-113 A
100k ohm
1 µf
SIGNATURES | DATE
DWG. A Carpenter | 3/9/89
CHK'D R. Chu | 4/7/89
MATERIAL: SEE ABOVE
TOLERANCES: N/A
FINISH: N/A
655 Aspen Ridge Drive
Lafayette, CO 80026
303/666-9234
LIFECARE
TITLE SCHEMATIC,CAP AUX BD
SCALE NTS
DWG NO 37E-970
REV A
FILE: 37E-970 A
SHEET # 1 OF 1 SHEETS


PLV-102
J2
TX
RX
D2
D3
D4 IN4001
D5
+5
R4
R3
100Ω 1/4W
U2
C2 22UF
C1 .1UF
C6 +22UF
C5 22UF
+10V
-10V
MAX 232
U1
R2 1/4W 5%
R1 1/4W 5%
100Ω
C3 22UF
C4 22UF
J1
9 PIN FEMALE
P.C.
J2
FRONT MALE
P.C. BOARD
J1
FRONT FEMALE
P.C. BOARD
C7 .1UF
U2 74LS14
LIFECARE®
SERIAL INTERFACE SCHEMATIC
37E-946
C


ECO
LTR
REVISION RECORD
DATE
APPROVED
1231 D R1 WAS 18K 11/18/85 P.C.
1283 E DWG WAS 35D-937 3/4/86 P.C.
1349 F DWG WAS 35P-937 6/2/86
LIFECARE RESPIRONICS, INC.
1501 FEDERAL AVENUE
BOULDER, COLORADO 80301
DATE 11/18/85
SHEET 1 OF 1
ZERO BOARD SCHEMATIC
PLV-100
DRAWN BY J. BAILEY
CHECKED
DRAWING NO 35E-937
REVISION F
5VDIG Gr,3
5V RETURN Y,2
OUT Or,1
P8
5
C1 .01µF
R1 220Ω
D1 TIL32
Q1 TIL78
R2 20K
R3 10K
Q2 MPS8098
R5 1K
Q3 MPS8098
R4 1M
ZERO CIRCUIT
Q4
G
D
S
Q4 IRF520
R7 1.5M
C2 1µF
D2 IN4001
D3 IN4001
R8 120Ω
+12
DUMP CIRCUIT
CATHODE
(+)
COLLECTOR
D1
Q1
J12
P42
P41
DUMP SOLENOID
+12V
ALARM
PRESSURE SWITCH
DC RETURN
EXTERNAL OF ZERO BOARD

RESPIRONICS®

1001 Murry Ridge Lane
Murrysville, PA 15668
USA

EC REP

Respironics Deutschland
Gewerbestrasse 17
82211 Herrsching, Germany

CE
0123

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